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FIRST BIENNIAL REPORT
OF THE
KANSAS WATER COMMISSION
1917-1918

BY
PROF. H. A. RICE, Secretary
AND
ROGER C. RICE, District Engineer, U. S. G. S.

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UNITED STATES GEOLOGICAL SURVEY

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KANSAS STATE PRINTING PLANT
W. R. SMITH, STATE PRINTER
TOPEKA. 1919

7-5311

KANSAS WATER COMMISSION.

COMMISSIONERS.

ARTHUR CAPPER, Governor, *ex officio* Chairman.

T. J. STRICKLER, Topeka. H. A. RICE, *Secretary*, Lawrence.

H. B. WALKER, *Engineer*, Manhattan.

J. B. MARCELLUS, *Acting Engineer*, Manhattan.

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LETTER OF TRANSMITTAL.

STATE OF KANSAS,
KANSAS WATER COMMISSION,
TOPEKA, KAN., December 31, 1918.

Hon. Arthur Capper, Governor:

SIR—Submitted herewith is the first biennial report of the Kansas Water Commission for 1917 and 1918, covering the work of the Commission since March 24, 1917, the date of organization.

To carry out more effectively the provisions of the Kansas Water Commission act (Session Laws of Kansas, 1917, chapter 172, p. 218), your attention is invited to the recommendations on pages 19 to 29. Very respectfully,

KANSAS WATER COMMISSION.

By H. A. RICE, *Secretary.*

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First Biennial Report of the Kansas Water Commission, 1917-1918.

INTRODUCTION.

The legislature of 1917 gave serious consideration to the formulation of a workable water conservation policy for Kansas. They held to the idea that such a policy would give shape and focus to future state legislation relating to flood control, drainage, water power, domestic water supply, navigation and irrigation problems, and that ultimately this policy would pave the way for greater economic development and insure a more stable agricultural prosperity for Kansas.

Coupled with these internal considerations was the growing need for a representative state water organization that could work with the federal government in the development of inland waterways projects, of which the state of Kansas forms an integral part. It was believed that such an organization should represent the state in matters pertaining to local, interstate and federal aid.

These considerations were embodied in a Water Commission bill (house bill No. 877) that was presented to the state legislature of 1917, and was one of the important legislative enactments of that body. The present Kansas Water Commission law (Session Laws of Kansas, 1917, chapter 172, p. 218) is the foundation upon which to enact additional legislation as needed to bring these several projects to successful completion.

THE KANSAS WATER COMMISSION ACT.

Chapter 172, Session Laws of Kansas, 1917 (page 218).

AN ACT relating to floods, drainage, water power, domestic water supply, navigation, irrigation, and providing for state control of all matters relating thereto, and providing for a Water Commission in the state of Kansas.

Be it enacted by the Legislature of the State of Kansas:

SECTION 1. A commission, which shall be known as the Kansas Water Commission, is hereby created for the purpose of investigating and controlling the problems of flood prevention, drainage, domestic water supply, water power, navigation and irrigation in the state of Kansas. But said Commission shall not interfere with any drainage system now established in drainage districts created under existing laws.

SEC. 2. The Kansas Water Commission shall be composed of three persons, of which the governor shall be *ex officio* chairman, and two civil engineers, who shall be, or qualified to be, at least associate members of the American Society of Civil Engineers, and shall be appointed by the governor to hold office for four years, or until their successors are appointed and qualified, and who shall be eligible for reappointment, and may be removed at any time by the governor for cause only. As soon as this act shall be in force the governor shall appoint one member whose term of office shall expire January 1, 1921, and one member whose term shall expire January 1, 1919; thereafter the governor shall appoint one

member on the first day of January in each odd-numbered year, and whose term of office shall expire on the first day of January four years thereafter. The members of said Commission shall serve without salary or other compensation, but the members thereof shall be allowed their actual traveling expenses when on official business of the Commission. Employees of the state may be appointed members of this Commission without vacating their positions or without change of compensation.

SEC. 3. This Commission is hereby authorized to secure such expert assistance, clerical and other help, and at such compensation as may be necessary to properly carry out the provisions of this act.

SEC. 4. As soon as practical after organization, the Commission shall, in conjunction with the federal government, by way of securing financial and professional aid and assistance, work out a systematic general plan for the complete development of each watershed in the state in order to secure the most advantageous adjustment of the interest involved in matters of floods, drainage, irrigation, water power and navigation. Where any department of the federal government is now or hereafter may be engaged in the development of plans effecting any of the subjects referred to in this act this Commission may cooperate with such federal department. Water development of all kinds throughout the state shall conform to the general plans adopted by the Commission.

SEC. 5. This Commission is hereby authorized and directed to establish and maintain river gauging stations and to make such surveys and other investigations as may be necessary to a complete knowledge of the subjects herein assigned to it for investigation.

SEC. 6. The following principles shall guide the Commission in its decisions and plans: (a) Surface or underground waters of the state may be appropriated by the federal government by civic decisions, by corporations, and by individuals upon application to the Commission, and in accordance with the rules and regulations it may prescribe. Such appropriations shall not constitute absolute ownership of such waters, but shall remain subject to the principle of beneficial use. (b) Where appropriations of water for different purposes conflict they shall take precedence in the following order, namely: domestic and transportation water supply, irrigation, industrial uses, water power. In each of these decisions prior application is to govern in making allotments. (c) Appropriation in excess of the reasonable needs of the appropriators not to be allowed. (d) Waters appropriated for irrigation are to become appurtenant to the lands to which they are applied, and underground waters for all purposes to become appurtenant to the lands under which they flow.

SEC. 7. The commission shall study the laws of the state relating to floods, drainage and irrigation, with a view to making such revisions as may be necessary to accomplish the ends prescribed in this act, and they shall report the results of their investigation and make such recommendations as they may deem proper to the legislature from time to time.

SEC. 8. The Commission and its agents shall have the power of entry on private lands for the purpose of carrying out the provisions of this act.

SEC. 9. All money now in the state treasury received from, or that may hereafter be received as compensation for sand taken from any navigable stream, except such amounts as drainage districts may be entitled to under the law, shall be placed in a separate fund, which shall be known as the Water Commission fund, and from which fund all expenses and obligations of the Water Commission shall be paid.

SEC. 10. The salaries of all employees of the Water Commission shall be fixed by said Water Commission.

SEC. 11. To carry out the provisions of this act and to coöperate with the federal government in all matters pertaining hereto, there is hereby appropriated for the remainder of the fiscal year ending June 30, 1917, the sum of \$1,000, or so much thereof as may be necessary; for the fiscal year ending June 30, 1918, the sum of \$3,000, or so much thereof as may be necessary; and for the fiscal year ending June 30, 1919, the sum of \$3,000, or so much thereof as may be necessary, which shall be expended under the direction of the Commission.

SEC. 12. This act shall take effect and be in force from and after its publication in the official state paper.

Approved March 13, 1917.

Published in official state paper March 24, 1917.

THE KANSAS WATER COMMISSION.

Purpose.

The law creating the Kansas Water Commission presents a clear and concise statement of the water-conservation policy for Kansas. The Commission is empowered to *investigate* and to *control* specific water problems: flood prevention, drainage, domestic water supply, water power, navigation and irrigation (section 1). The magnitude and importance of such a program is worthy of careful consideration.

The Organization.

Section 2 provides for the organization of a commission of three members: the governor as *ex officio* chairman, and two civil engineers, "who shall be, or be qualified to be, at least associate members of the American Society of Civil Engineers."

The water problems before the Water Commission are engineering matters of a high order, that will require broad and intelligent treatment. It is altogether fitting that the high standards of the American Society of Civil Engineers should be adopted for the personnel of the Commission.

It may seem inconsistent that "the members of said commission shall serve without salary or other compensation," or that "employees of the state may be appointed members of this Commission without vacating their present positions or without a change of compensation." These matters are involved in the financing of the Water Commission, which is of particular importance.

How Financed.

Section 9 of the Water Commission law provides that—

"All money now in the state treasury received from, or that may hereafter be received as compensation for sand taken from any navigable stream, except such amounts as drainage districts may be entitled to under the law, shall be placed in a separate fund, which shall be known as the Water Commission fund, and from which fund all expenses and obligations of the Water Commission shall be paid."

In other words, the investigations of the Kansas Water Commission are to be financed from the revenue derived through the workings of the so-called Kansas sand law, passed by the legislature of 1913, chapter 259, Session Laws of Kansas, 1913, which reads in part as follows:

"An act relating to the sale and taking of sand, oil, gas, gravel, mineral and any other natural product whatsoever from the bed of any river which is the property of the state or any island therein . . . prescribing certain powers and duties of public officers in relation thereto; . . ."

Under the provisions of this act the natural products that had hitherto been taken by private concerns without any revenue going to the state treasury are now considered natural resources belonging to the state, for which royalties, determined by the Executive Council, must be paid into the state treasury, ways and means being provided to enforce this law. The exception mentioned in section 9 of the Water Commission law is covered in section 2 of the sand act, as follows:

"Where any navigable stream extends into or through any drainage district in the state organized under chapter 215 of the Session Laws of 1905, and the amendments thereto, the board of directors of such district shall be entitled to one-third of the proceeds of such natural products or minerals which the state may sell from within or beneath a portion of the channel of such streams lying within such district, and said one-third of the proceeds arising from any such sale shall be paid to the treasurer of such drainage district and shall be expended only by such district for any of the purposes for which such district was created."

The Kansas sand law was made inoperative by litigation that was still pending before the supreme court of Kansas at the time the Kansas Water Commission bill was under consideration. The means to finance immediately the work of the Commission were, therefore, not available, so emergency measures had to be adopted pending a favorable decision on the constitutionality of the Kansas sand law, in order that the water conservation policy, as embodied in the Water Commission bill, could be adopted by the 1917 legislature. For this expediency it became necessary to require the commissioners to serve without compensation, and also to enlist the support of engineers already in the employ of the state in responsible positions to assume these additional responsibilities, also without compensation.

To provide for necessary field investigations for stream gaging, and to enlist the coöperation of the federal government in this work, small appropriations from the general fund were made for the balance of the fiscal year 1917, and for the fiscal years 1918 and 1919, respectively.

Constitutionality of the Kansas Sand Law Determined.

The supreme court of the state of Kansas in 1917 ruled that the Kansas sand law was constitutional. However, the case was appealed to the United States supreme court. On November 26, 1917, the United States supreme court rendered a decision upholding the constitutionality of the Kansas sand law. The state of Kansas could then assert its sovereignty to the "bed and channel of any river in the state or bordering on this state to the middle of the main channel thereof and all islands and sand bars lying therein," certain legal exceptions to the contrary being specifically mentioned in the law (section 6, chapter 259, Session Laws of Kansas, 1913).

Appropriation Not Specified by Water Commission Law.

The attorney-general ruled that section 9 of the Water Commission law (relating to financing the work from the revenue derived from sand royalties) did not make the sand royalties immediately available for the investigations of the Kansas Water Commission, but that these moneys were held in trust, in a Water Commission fund, subject to future appropriations by the state legislature. This decision precluded the formation of a larger organization by the Water Commission until an appropriation from the Water Commission fund should be made by the legislature of 1919.

COOPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY.

The flood-control problem for eastern Kansas was given attention by the Kansas Water Commission as soon as organized. Certain hydro-metric investigations bearing on the flood problem needed to be started without delay. In accordance with sections 4 and 5 of the Water Commission law, on May 11, 1917, a coöperative agreement was made between the United States Geological Survey and the Kansas Water Commission for an investigation of the water resources of Kansas.

Cooperative Agreement.

"THIS AGREEMENT, made May 11, 1917, by and between the United States Geological Survey, by George Otis Smith, director, party of the first part, and the Kansas Water Commission, by T. J. Strickler, secretary, party of the second part:

WITNESSETH:

1. The parties hereto covenant and agree that, in accordance with their respective statutory authorities, copies of which are attached hereto, there shall be maintained, in coöperation, an investigation of the water resources of the state of Kansas.

2. That the parties hereto shall contribute for the purpose of carrying on these investigations and for preparing the results thereof for publication the following amounts: (a) The party of the first part at least \$2,000 annually, to be expended during the biennium ending June 30, 1919; said allotment to depend on appropriation by Congress. (b) The party of the second part at least \$2,000 annually, to be expended during the biennium ending June 30, 1919.

3. The areas to be investigated and the scope of the investigation shall be determined by mutual agreement between the parties hereto and their respective representatives.

4. The areas to be investigated and the nature of the investigations having been determined, the field and office work necessary therefor shall be under the direction of the party of the first part, who shall, by a duly accredited representative, supervise the expenditure of the funds contributed by both parties and shall approve vouchers for all such expenditures. The methods of investigation and the regulations governing them shall be those usually followed by the party of the first part, provided that they may be subject to such modification as is suggested by the party of the second part and approved by the party of the first part.

5. During the progress of the work all records pertaining thereto shall be open to the inspection of the party of the second part, and if the work is not being carried on in a manner satisfactory to the party of the second part, he may, on formal notice, terminate this agreement.

6. Accounts and expenses incurred in the performance of the work herein provided shall be rendered monthly in the manner required by the laws and regulations of the parties hereto and shall be paid in accordance therewith.

7. Certified copies of all results of investigations shall be furnished to the party of the second part on demand. The original records should ultimately be deposited in the office of the party of the first part, and shall become part of the records of said office.

8. The results of the work contemplated in this agreement shall be published by and in the regular annual reports of the party of the first part, and said publications shall contain a statement of the coöperative relation between the parties hereto. The party of the second part reserves the right to publish all results of said investigations, it being understood that at least sixty (60) days shall be given the party of the first part for the proper assembling and compiling of any data desired for such state reports.

IN WITNESS WHEREOF, We have hereunto set our hands and seals this eleventh day of May in the year one thousand nine hundred and seventeen.

GEO. OTIS SMITH, *Director,*
For and on Behalf of the United States Geological
Survey, Party of the First Part.

T. J. STRICKLER, *Secretary.*
For and on Behalf of the Kansas Water Commission,
Party of the Second Part."

Organization.

Through the courtesy of the United States Treasury Department and W. O. Rigby, postmaster at Topeka, Kan., the United States Geological Survey was enabled to secure adequate office space in the Federal Building as headquarters for the investigations in Kansas. This included files and office furniture.

The district office was opened on June 1, 1917, at Room 25, Federal Building, Topeka, Kan., with Roger C. Rice as district engineer.

The limited appropriations of both the United States Geological Survey and the Kansas Water Commission have restricted the investigations to the activities of the district engineer. Although entirely inadequate for securing the amount of data needed in the solution of the flood problem, this organization has made definite progress.

KANSAS WATER COMMISSION AND U. S. GEOLOGICAL SURVEY.

SUMMARY OF EXPENDITURES FOR HYDROMETRIC INVESTIGATIONS IN KANSAS FOR PERIOD
MAY, 1917, TO NOVEMBER, 1918.

Expenditures.			Principal cost items.					
Kansas Water Commission.	U. S. Geological Survey.	Total.	Stream gaging—field work.			Office work, reports.	*Top cost.	Non- expendable property.
			Observers.	Operation and maintenance of gaging stations. including observers.	Construction of gaging stations.			
FISCAL YEAR 1917 (MAY AND JUNE, 1917, ONLY)								
\$931.07	\$243.49	\$1,174.56	\$6.84	\$172.38	\$457.10	\$75.00	\$144.08	\$326.00
FISCAL YEAR 1918.								
\$2,814.28	\$2,612.36	\$5,426.64	\$297.18	\$1,401.01	\$1,522.76	\$894.39	\$615.05	\$993.43
FISCAL YEAR 1919 (JULY TO NOVEMBER, 1918, ONLY).								
\$1,842.27	\$1,188.38	\$3,030.65	\$205.50	\$838.68	\$2,005.01	\$89.05	\$77.66	\$20.25

*Top cost includes: Administration, filing, correspondence, supervision, conference, fixed charges, rent, telegrams, etc.

Stream-gaging Investigations.

The joint work of the Kansas Water Commission and the United States Geological Survey during the period, June 1, 1917, to December 31, 1918, has been the establishment and maintenance of stream-flow measuring stations at strategic points selected as part of the systematic investigation of the drainage basins in eastern Kansas, together with special investigations.

The following gaging stations have been established in Kansas since June 1, 1917:

STREAM FLOW MEASURING STATIONS IN KANSAS, AND DATE ESTABLISHED.

Kaw valley.

Kansas river basin.

Kansas river at Odgen. (June 19, 1917.)

Kansas river at Topeka.¹ (June 12, 1917.)

Kansas river at Bonner Springs. (July 8, 1917.)

Smoky Hill river basin.

Smoky Hill river at Ellsworth. (July 23, 1918.)

Smoky Hill river at Sand Springs, near Abilene. (June 19, 1918.)

1. Equipped with Gurley long-distance water-stage register, located at the United States Weather Bureau office.

Solomon river basin.

Solomon river near Bennington. (October 1, 1917.)

Republican river basin.

Republican river at Wakefield. (June 21, 1917.)

Blue river basin.

Blue river at Randolph. (April 16, 1918.)

Marais des Cygnes valley.

Marais des Cygnes river near Ottawa.² (October 26, 1918.)

Neosho river valley.

Neosho river near Iola.³ (October 12, 1917.)

Except as indicated, the above gaging stations are equipped with standard chain or staff gages, which are read twice a day by gage observers. With the exception of Neosho river near Iola, near-by bridges are utilized as measuring sections from which to measure the discharge.

Special Investigations.

Kansas City Northwestern Railway Company's Bridge Controversy. In August, 1917, at the request of Governor Arthur Capper, *ex officio* chairman of the Kansas Water Commission, the Commission prepared a preliminary report on "The effect of obstruction to navigation and flood prevention by the Kansas City Northwestern Railway Company's bridge on the Kansas river at Kansas City, Kansas." Copies of this report may be obtained upon application to the Kansas Water Commission.

This report was presented to the War Department by the Kansas Water Commission at the public hearing held September 11, 1917, before Col. Willard Young, United States agent in United States engineer's office at Kansas City, Mo., to consider the application of the Kansas City Northwestern Railway Company for the approval of its plans for the alteration of its bridge across Kansas river at Kansas City, Kan.

"The Relation of the Kansas Water Commission to the Flood Problem of Kansas." This report by the Kansas Water Commission, dated January 12, 1918, outlines the progress made in Kansas leading toward the solution of the flood problem, and further investigation by the Kansas Water Commission. Copies of the report are on file with the Kansas Water Commission.

"Water Resources of Kansas." A compilation of all available United States Geological Survey stream-flow data for Kansas, together with all the available United States Weather Bureau rainfall data for Kansas, was started by the Geological Survey in November, 1917, for publication as a special water-supply paper, to be known as "Water Resources of Kansas." The tabulated and descriptive matter for this report was practically completed before the 1918 field season temporarily discontinued the work. The report is 75 percent complete.

Other Cooperation.

The stream-gaging investigations of the Kansas Water Commission and the United States Geological Survey have been materially assisted

2. Equipped with Stevens water-stage recorder.

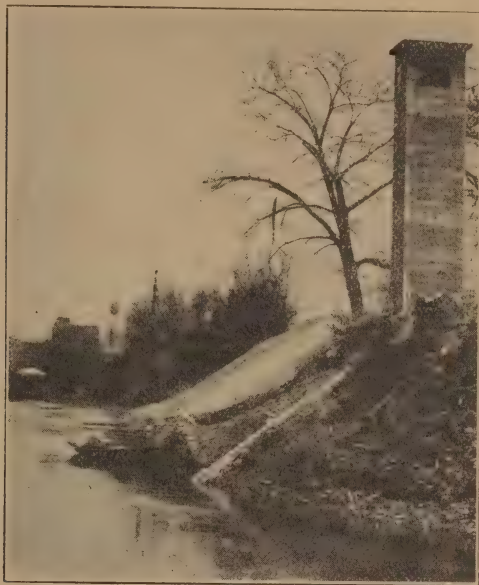
3. Equipped with Stevens water-stage recorder, with car and cable at measuring section.

PLATE I.

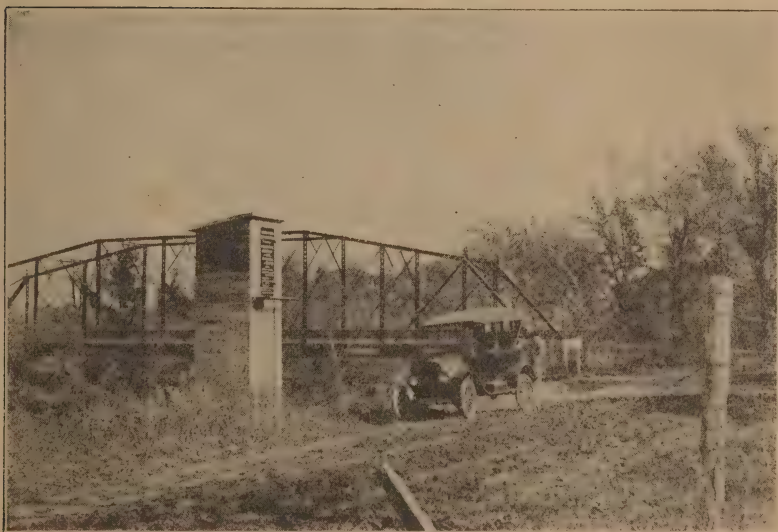
KANSAS WATER COMMISSION.



KANSAS RIVER AT TOPEKA DURING 1903 FLOOD.



A. Well and shelter for recording gage on Kansas River at Topeka, Kan., constructed by North Topeka Drainage District and South Side Levee District No. 6, at Topeka, Kan.



B. Stream-flow measuring station on Marais des Cygnes River near Ottawa, Kan., showing well and shelter for recording gage and bridge measuring section.

through the final coöperation of the United States Weather Bureau and several local organizations.

The North Topeka Drainage District and the South Side Levee District No. 6, of Topeka, constructed a reinforced concrete well and shelter for a long-distance recording river gage on Kansas river at Topeka (Pl. IV, A), which was completed in the spring of 1918.

In 1918 the United States Weather Bureau transferred the center of forecast work for Kaw valley (Pl. I) from Kansas City, Mo., to Topeka, Kan. Mr. S. D. Flora, meteorologist in charge at Topeka, was granted authority to make use of all gaging stations maintained by the Kansas Water Commission in Kaw valley that coördinated with the existing river gages maintained by the Weather Bureau, in order that flood forecast work for Kaw valley might be more effective. The United States Weather bureau is coöperating in the maintenance of the long distance water-stage register, which forms part of the equipment for the stream-flow measuring station on Kansas river at Topeka. This instrument has been placed in the Weather Bureau office at Topeka by the Water Commission and the Geological Survey, and will be used as an intergal part of the flood forecast work for Kaw valley.

Franklin county, Kansas, coöperated in the construction of the stream-flow measuring station on Marais des Cygnes river near Ottawa, Kan. (Pl. IV, B), completed in October, 1918, by furnishing the crushed rock used, some 25 cubic yards, and the steel reinforcing, some 1,364 pounds. Total financial coöperation was \$120.85.

The city of Ottawa, Kan., also coöperated in the construction of this stream-flow measuring station by hauling the crushed rock and sand. They also furnished two telephone poles used in the construction of the outside staff gage. This financial coöperation is estimated at about \$60.

The property owners in the vicinity of this measuring station willingly agreed to clear the river banks of overhanging trees and brush to improve the channel at the measuring section.

National Drainage Congress.

(Seventh Annual Meeting at Chicago, Ill., December 13 and 14, 1918.)

Governor Arthur Capper appointed Prof. H. A. Rice, secretary of the Kansas Water Commission, as delegate to the seventh annual meeting of the National Drainage Congress, held at Chicago, Ill., on December 13 and 14, 1918.

At this meeting 130 delegates from the various states were present to consider matters of state and national importance relating to flood and drainage and other reclamation work.

The National Drainage Congress is urging national recognition of water projects, especially inland drainage of swamp and overflowed lands, and flood protection. It recommended to the United States Congress that a billion dollars be set aside for this purpose.

The flood problem of Kansas, and especially that of the Kaw valley, was presented to the Drainage Congress by Prof. H. A. Rice, and was fully discussed by other delegates.

Recommendations—Summary.

Before proceeding with the detailed discussions upon which recommendations are based, this brief summary is submitted:

1. An appropriation from the Water Commission fund by the legislature of 1919 is necessary to finance the work of the Kansas Water Commission and establish it upon a permanent basis.

2. Appropriations of \$25,000 for the fiscal years 1920 and 1921, respectively, are recommended to be appropriated from the Water Commission fund for the Kansas Water Commission. These appropriations are for—

(a) Hydrometric investigations in coöperation with the United States Geological Survey, \$20,000 per year.

(1) Operation and maintenance of stream-flow measuring stations now established.

(2) Construction, operation and maintenance of other stream-flow measuring stations to be established during fiscal years 1920 and 1921.

(3) Coöperation in stream-gaging investigations with Kaw Valley Drainage District.

(4) Investigation of developed and undeveloped water power in Kansas.

(5) Special investigations relating to flood control, irrigation and other water problems.

(6) Preparation of reports for publication by Kansas Water Commission and United States Geological Survey.

(b) Other investigations by Kansas Water Commission, \$5,000 per year.

(1) Detailed river surveys for assisting flood prevention, drainage and other water problems in accordance with section 5 of the Water Commission act (see page 8.)

(2) Codification of existing water laws of Kansas by qualified experts, with recommendations for further legislation, in accordance with section 7 of the Water Commission act (see page 8).

(3) Special investigations relating to flood control, irrigation and other water problems.

3. A deficiency appropriation of \$1,000 for the balance of the fiscal year 1919 is requested to provide for field expenses for stream gaging during the spring of 1919, and for clerical assistance.

4. It is further recommended that the Kansas Water Commission approve all plans and have general supervision of all construction work of drainage districts established after June 30, 1919.

5. It is also recommended that legislation be enacted providing for the clearing of river banks and river channels in eastern Kansas as an immediate and partial flood relief measure.

RECOMMENDATIONS—DISCUSSION.

Appropriation from Water Commission Fund by Legislature of 1919 Necessary to Finance Kansas Water Commission.

Emergency appropriations from the general funds in the state treasury were provided for the work of the Kansas Water Commission by the legislature of 1917, as follows (see page 9):

"SEC. 11. To carry out the provisions of this act and to coöperate with the federal government in all matters pertaining thereto, there is hereby appropriated for the remainder of the fiscal year ending June 30, 1917, the sum of \$1,000, or so much thereof as may be necessary; for the fiscal year ending June 30, 1918, the sum of \$3,000, or so much thereof as may be necessary; and for the fiscal year ending June 30, 1919, the sum of \$3,000, or so much thereof as may be necessary, which shall be expended under the direction of the Commission."

The permanent financing of the work of the Commission is provided for in section 9 of the Water Commission act (see page 8), as follows:

"SEC. 9. All money now in the state treasury received from, or that may hereafter be received as compensation for sand taken from any navigable stream, except such amounts as drainage districts may be entitled to under the law, shall be placed in a separate fund, which shall be known as the Water Commission fund, and from which fund all expenses and obligations of the Water Commission shall be paid."

It is therefore respectfully urged that the legislature of 1919 make definite and permanent appropriation of the Water Commission fund in accordance with the provisions of section 9, in order that the investigations of the Kansas Water Commission may be put on a sound and lasting basis.

On September 19, 1918, according to the state auditor, there was \$41,074.28 in the Water Commission fund. About \$10,000 additional remained undivided between the drainage districts entitled to their share, and the Water Commission fund. This fund has been accumulating from sand royalties paid into the state treasury since 1913, through the operation of the Kansas sand law, by sand companies operating at favorable sites in Kansas and Arkansas valleys in eastern Kansas. The supply of sand is apparently inexhaustible. The demands for it for building purposes, which are now large, are bound to increase with the renewal of construction work permitted by the government. This natural resource is, therefore, an asset of increasing value to the state.

Other states which have water problems similar to those in Kansas, but which are less favored in the utilization of their natural resources, must depend upon appropriations for the work from general taxation. Kansas, on the other hand, is able to make her rivers finance her water projects and thereby ease the burden of taxation on her citizens. For these revenues are to be used by the Kansas Water Commission for investigations of water problems of vital importance to the welfare and prosperity of *all* sections of the state.

Budget for Biennial Period for Fiscal Years 1920 and 1921.

The following budget for the fiscal years 1920 and 1921 is recommended to finance the investigations of the Kansas Water Commission:

(a) For hydrometric investigations in cooperation with United States Geological Survey (sections 4 and 5), \$20,000 per year. This provides for the following organization for stream gaging, operation and maintenance of stream-flow measuring stations, and new construction, as follows:

	1920.	1921.
(1) Field and office organization:		
District engineer, 12 × \$210	\$2,520	\$2,520
Office engineer, 12 × \$160	1,920	1,920
Clerk-stenographer, 12 × \$100	1,200	1,200
Assistant engineer, 12 × \$160	1,920	1,920
Junior engineer, 12 × \$135	1,620	1,620
Totals	\$9,180	\$9,180
(2) Gage observers, 40 × 12 × \$5	2,400	2,400
(3) Traveling expenses, 12 × \$200	2,400	2,400
(4) Installation of staff gages, 26 × \$50	1,300	.....
(5) Installation of automatic gages:		
3 at \$1,500 each	4,500	.....
4 at \$1,500 each .....	.....	6,000
(6) Instruments, etc.	220	20
Totals	\$10,820	\$10,820
		\$20,000

(b) For other investigations (sections 5 and 7), \$5,000 per year, as follows:

(1) River surveys (section 5)	\$4,000	\$4,000
(2) Codification of water laws of Kansas by qualified experts (section 7)	500	500
(3) Special investigations	500	500
Totals	\$5,000	\$5,000
		\$5,000
Total annual budget for fiscal years 1920 and 1921		\$25,000

Deficiency Budget for the Balance of the Fiscal Year 1919.

The following deficiency budget of \$1,000 from the Water Commission fund for the balance of the fiscal year 1919 is urged:

(1) Field work for stream gaging	\$550
(2) Clerical assistance, 6 months at \$75	450
Total	\$1,000

These funds are needed to permit necessary field work during the high-water periods of May and June, 1919, and also for much-needed clerical assistance in computing and compiling data for publication. The deficiency appropriation requested will enable the making of stream-flow measurements at gaging stations now maintained and the securing of other flow data during high water that otherwise the Commission will be unable to obtain.

Hydrometric Investigations in Cooperation with the United States Geological Survey.

THE IMPORTANCE OF RELIABLE STREAM-FLOW DATA.

The solution of the flood problem for Kansas, which is the most important work of the Kansas Water Commission, involves an intimate study of the flow of all flood-producing streams in Kansas, as well as a comprehensive study of the excessive rainfalls that cause these floods.

Any extensive project aimed at the regulation and control of a river system must be based upon adequate information pertaining to stream flow.

Stream-flow records covering a long term of consecutive years are the most reliable information that can be secured upon which to base recommendations for flood protection. For this reason those stream-flow records secured in Kansas by the United States Geological Survey during 1895-1906 have been invaluable in assisting in the flood-prevention plans that have been developed or proposed in Kansas up to the present. Between 1906 and 1917 no continuous record of the discharge of Kansas streams were secured. In consequence the much-needed data on the volume of the floods that occurred in the interim, especially those of 1908 and 1915 in Kaw valley, have not been secured.

PROPOSED ORGANIZATION FOR STREAM GAGING.

The Kansas Water Commission, through the coöperation of the United States Geological Survey, is now reëstablishing this important investigation in Kansas, and has plans for enlarging the scope of these hydrometric investigations in order that water problems other than that of flood control will be benefited thereby.

The present organization of one engineer will be enlarged to four engineers specially trained in this work, and a clerk-stenographer, who will also do all the clerical work of the Commission.

Gage observers for each of the stream-flow measuring stations maintained report daily river stages throughout the year, and other data pertaining to the flow of the river at their stations.

Field work for stream-gaging investigations involves a great deal of traveling throughout the state, as the gaging stations are widely distributed. As far as practicable, measurements of discharge will be made at each gaging station at least once a month, and oftener during periods of high water.

At present ten stream-flow measuring stations (see page 14) are maintained on limited funds. The enlarged organization will enable the Commission to establish and maintain about thirty additional stations distributed in the various river valleys throughout the state. The most important of these stations will be equipped with automatic water-stage recorders. (Pl. III.)

Locations for the new gaging stations will be investigated as soon as practical after definite appropriations have been made for the work of the Water Commission, and will be established as rapidly as possible.

Among the sites for suitable stations that will receive early attention are these:

STREAM-FLOW MEASURING STATIONS IN KANSAS PROPOSED BY
KANSAS WATER COMMISSION.

Kaw valley:

- Saline river—Lincoln.
- Republican river—Republican.
- Blue river—Marysville.

Marais des Cygnes valley:

- Cottonwood river—Cottonwood Falls.
- Cottonwood river, North Fork—Cottonwood Falls.
- Little Neosho river—Council Grove.
- Neosho river—Oswego.

Verdigris valley:

- Verdigris river—Independence.

Arkansas valley:

- Arkansas river—Syracuse.
- Arkansas river—Wichita.

STREAM GAGING IN KANSAS.

In general, stream-flow gaging stations (Pl. II. *B*) require the following equipment:

1. A gage or gages for determining fluctuations of stage.
2. Bench marks for referring the gages to a fixed datum.
3. Structures from which discharge measurements are made.
4. Equipment for making current meter measurements.

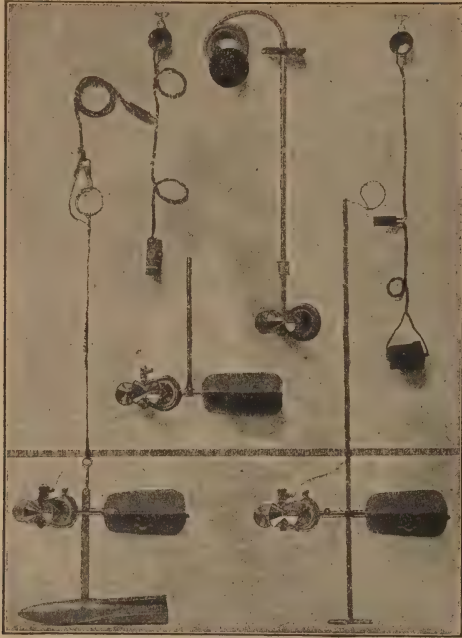
GAGES. Two classes of gages are used in stream-flow measuring work to measure the fluctuations of water level. These are nonrecording and recording gages. Nonrecording gages in common use are the vertical-staff gage, the inclined-staff gage, and the chain gage. These have to be read directly at stated intervals and require the service of an observer, who lives, usually, in the vicinity of the gage.

Recording gages (Pl. III) obtain the record of the stage by some form of mechanism and operate independently of an observer. They make a record of stage, either continuously by a curve, the coördinates of which indicate the time and the stage, or by a device that prints the stage at regular intervals of time.

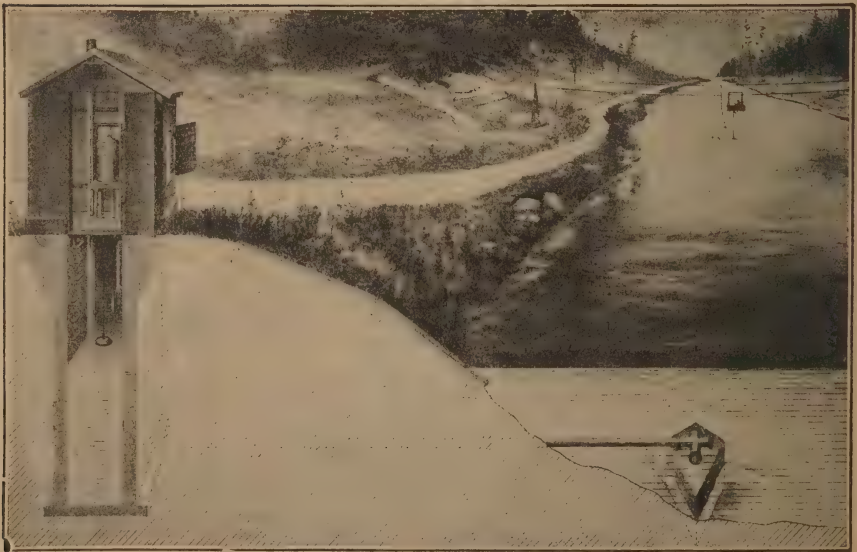
Often the selection of a suitable gaging station depends primarily on whether or not an observer is available. The recording gage, however, allows the gaging station to be selected at the best location of the river, which is usually isolated.

In the past few years recording gages have been largely replacing the nonrecording gages on important investigations. This change has come about through a better appreciation of the value of stream-flow records, and the demand for more accurate determinations of stream flow by coöperating parties.

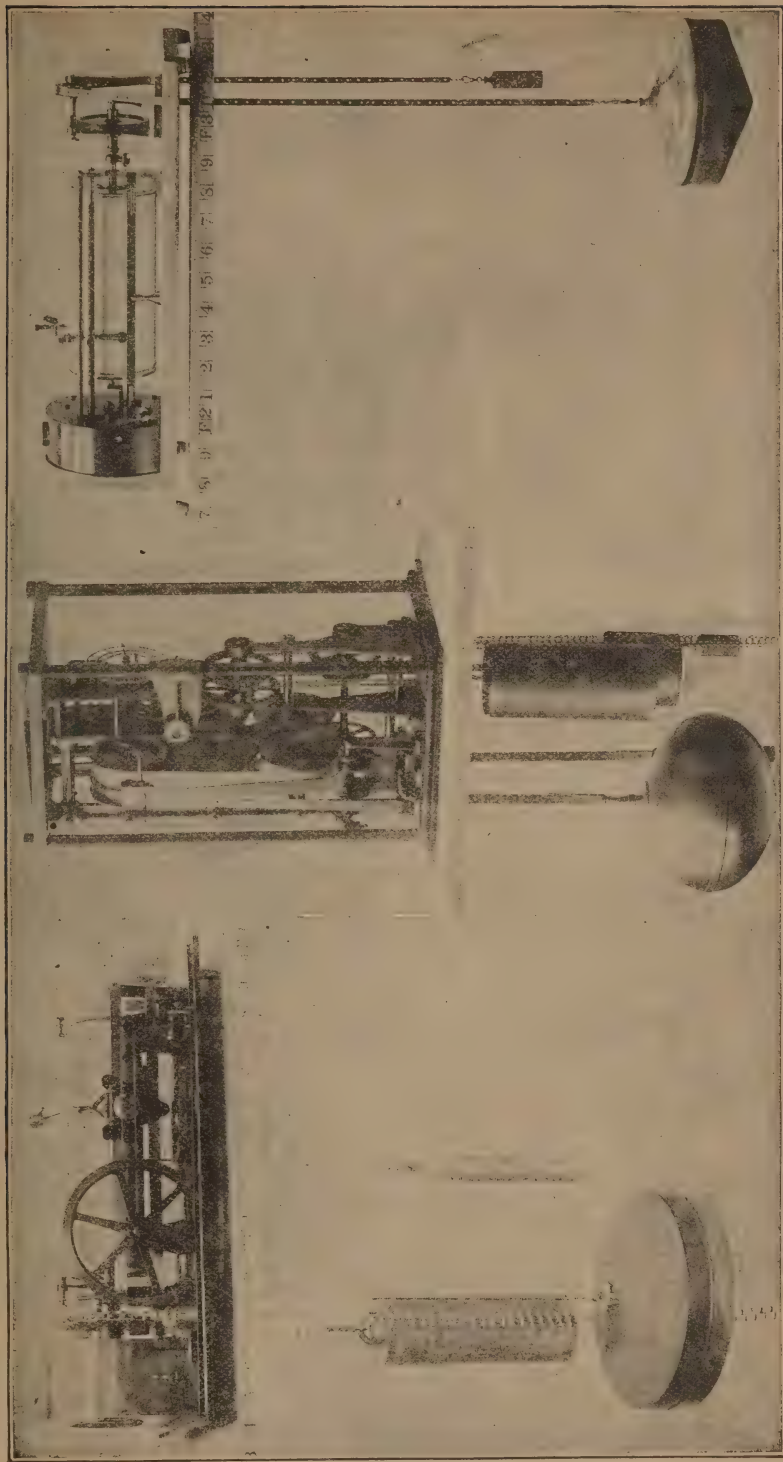
MEASUREMENT OF DISCHARGE: THE CURRENT METER. The determination of the discharge of a stream involves the measurement of two quantities: area of the cross-section and the mean velocity of flow. The practice of the United States Geological Survey is to measure the velocity of flow *indirectly* by means of a current meter, an instrument consisting of a wheel with cups or vanes, so constructed that the impact of the



A. PRICE CURRENT METERS.



B. TYPICAL GAGING STATION.



A. STEVENS.

B. GURLEY PRINTING.
WATER STAGE RECORDERS.

C. FRIEZ.

flowing water causes this to revolve, the number of revolutions being indicated by means of some form of recording device. The instrument has been previously rated, so that for a given number of revolutions in a given time the equivalent velocity of the flowing water is readily calculated. Current meters may be divided into two classes: (1) those of the Price meter type, in which the cups revolve about a vertical axis; and (2) those of the Haskell or the Fteley type, in which the vanes revolve about a horizontal axis.

The Price current meter (Pl. II. A), has been largely developed and extensively used by the United State Geological Survey in its hydrometric investigations throughout the United States and the territories of Hawaii and Alaska. In its present improved form it may be used to measure all sizes of streams. The meter outfit has also been designed to meet the demand for lightness, compactness, durability and strength.

MEASUREMENT OF DISCHARGE: HOW MADE. Discharge measurements at medium and high stages are usually made by operating the current meter from a bridge or from a movable car suspended on a cable stretched across the stream. At low stages measurements are usually made by wading, as this enables the selection of a measuring section upstream or downstream from the gage at which the conditions are better for determining the discharge than at the regular high-water section. At high stages, when the meter is used on an insulated cable, it is necessary to add lead weights to the meter hanger to keep the meter submerged. Torpedo-shaped weights have been designed, as these offer a minimum of resistance to the water.

MEASUREMENT OF DISCHARGE: THE STAGE-DISCHARGE RELATION. Each discharge measurement is referenced to the gage, and a sufficient number of measurements are made at different stages to develop the relation between the stage (gage height) and the discharge. These measurements, when plotted with gage heights as ordinates and discharge as abscissae, usually define some representative curve, generally parabolic in shape, that is called the "rating curve" or the "stage-discharge relation." When the channel control for the gage is permanent, this relation shows little change from year to year. For such gaging stations a minimum of field work is required, and the cost of operation is low. After the stage-discharge relation has been well defined, only occasional measurements are required to check the rating curves from year to year.

Unfortunately, such favorable stream-gaging conditions are the exception rather than the rule for Kansas rivers. It is necessary to keep on making measurements and "rerating" the gaging stations each year, as the unstable river beds do not yield permanent relations between stage and discharge. Failure to secure needed high-water measurements in a field season may make it impossible to determine the stage-discharge relation for these high-water periods.

COÖPERATION IN STREAM-GAGING INVESTIGATIONS WITH KAW VALLEY DRAINAGE DISTRICT.

Preliminary investigation of the flood problem on Kansas river at Kansas City, Kan., by the Kansas Water Commission in the summer of 1917 (see page 15) brought out clearly the need of more intensive stream-gaging investigations by the Kaw Valley Drainage District than

the limited funds available for such work by the Kansas Water Commission and the United States Geological Survey permitted. The Drainage District was advised to give this matter serious consideration as soon as possible.

The consulting engineers for the Kaw Valley Drainage District, Alvord and Burdick, of Chicago, Ill., made a report to the board of directors of the Kaw Valley Drainage District, Wyandotte county, Kansas, in September, 1918, upon "The adequacy of its flood-protection works and its plans for the completion thereof." In this detailed report the calculation of the flood volumes were based directly upon the stream-flow records for Kaw valley obtained by the United States Geological Survey during 1895-1906. The importance of further stream-flow investigations for the drainage district was pointed out by Alvord and Burdick in their report, as follows (page 42 of their report):

"Facilities for Collecting Flow Data.

"In any construction project upon the adequacy of which the safety of lives and property are dependent, all elements of uncertainty should be eliminated in so far as possible. The greatest uncertainty in flood-protection design is in the amount of flow for which provision should be made. The adopted flow must be predicated upon the recorded flows of the past, which rarely extend beyond a few years. It is, therefore, important that a flood-protection body such as the Kaw Valley Drainage District should collect and preserve the data so essential to the safe design of the ultimate improvement and its operation.

"The district should install and maintain water-level gages, which should be read daily throughout the year and at more frequent intervals during the periods of flood flow. Gages may be either of the recording float type or plain staff gages, depending upon the locations selected for the gages. Two gages should be installed, one near the mouth of the Kaw and the other upstream such distance as will remove it from any influence from the Missouri river.

"The latter gage should be established at some point along the river where the channel is straight and relatively regular and well adapted for the location of a river gaging station. The district should purchase a current meter and establish a rating curve at this station, so that the daily gage heights may be expressed in terms of water flowing. Gagings should cover as wide a range in flows as possible.

"During the floods frequent gagings by current meter should be made, and the district's engineers should have available the necessary equipment and facilities for doing this work promptly."

The board of directors of the Kaw Valley Drainage District has advised with representatives of the United States Geological Survey and the Kansas Water Commission in the matter of installing a recording gage on Kansas river at Bonner Springs, which is above the backwater influence of Missouri river, and also one on Kansas river at Kansas City, Kan., on the regulated section, which is within the influence of the Missouri.

On December 30, 1918, the following letter from the Board of Directors, outlining definite proposed coöperation, was received:

THE KAW VALLEY DRAINAGE DISTRICT,
KANSAS CITY, KAN., December 30, 1918.

Roger C. Rice, District Engineer, U. S. Geological Survey, Topeka, Kan:

DEAR SIR—In the matter of the construction of gaging stations for the Kansas river, you are advised that the board of directors of the Kaw Valley Drainage District will coöperate with the federal government and

the Kansas Water Commission, through you, in the construction of a gaging station at Bonner Springs and at East Kansas avenue in Kansas City, Kan.; that the district will pay for the construction of the gaging station and equipment at Bonner Springs, except the gaging instrument, which is to be furnished by the government. It is also understood that the government will assist in preparing plans and assist the chief engineer of the drainage district in superintending the construction of the gaging stations.

It is also understood that the government and the Kansas Water Commission will make current meter reports of the flow and rate the stations, and will furnish estimates and reports that are usual for this work to the drainage district free of cost.

Respectfully,

By order of Board of Directors Kaw Valley Drainage District.

J. W. SILVERS, *Secretary.*

The enlarged organization for stream-gaging investigation will enable the Kansas Water Commission to carry out effectively its part in this coöperation. The proposed automatic gages in this portion of Kaw Valley will also aid the United States Weather Bureau at Topeka in perfecting its flood forecast work for Kaw valley.

INVESTIGATION OF DEVELOPED AND UNDEVELOPED WATER POWERS IN KANSAS.

In conjunction with the program for stream-gaging investigations in Kansas by the enlarged organization, it is planned to include an investigation of developed and undeveloped water powers in Kansas. Such an investigation should prove of considerable value, not only to those power companies who utilize water power, but by municipal and state organizations as well. The coöperation of all interested parties will be invited to make this study as comprehensive as possible.

SPECIAL INVESTIGATIONS RELATING TO FLOOD CONTROL, IRRIGATION AND OTHER WATER PROBLEMS.

The Kansas Water Commission has been called upon from time to time during 1917 and 1918 to undertake special investigations of water supply, drainage and flood control involving field investigations. Owing to limited funds these investigations have not been possible. With the enlarged organization, however, it is believed that a limited number of these special investigations can be handled in connection with the stream gaging investigations.

Other Investigations by Kansas Water Commission.

RIVER SURVEYS.

In the study of the flood problem, as well as the related problems of water power and drainage, certain physical data must be available to determine a comprehensive plan of control for each valley.

Surveys and reports bearing upon the flood problems in the Neosho and Marais des Cygnes valleys have been made by the United States Department of Agriculture.

In accordance with section 5 of the Water Commission act (see page 8) it is recommended that a detailed topographic survey of the valley floor for Kaw valley, including Kansas river and its principal tributaries, and extending to the limits of the flood-producing areas, be started without delay. This survey should include, besides the drainage map drawn

to large scale, river profiles, and studies of possible reservoir sites. The map should show the extent of flooded areas by different floods, the location of debris, such as old bridge steel, piers and similar wreckage lying in the bed of the rivers; the character of the river banks, together with such information from local sources as may have bearing on the flood problem.

The sum of \$8,000 for the biennial period ending June 30, 1921, has been included in the budget for this survey.

It is recommended that the coöperation of the Topographic Branch of the United States Geological Survey be secured for this project.

CODIFICATION OF EXISTING WATER LAWS OF KANSAS.

Existing laws of Kansas relating to floods, drainage and irrigation are spread over many years and appear in the session laws of each legislature. Many of these laws are obsolete, and others need to be revised to make them effective.

In accordance with section 7 of the Water Commission act, \$1,000 has been included in the budget for the biennial period ending June 30, 1921, for the codification of these laws by qualified experts, in order that recommendations may be made to the legislature for the enactment of more effective water laws.

Further Recommendations.

SUPERVISION OF PLANS AND CONSTRUCTION WORK OF NEW DRAINAGE DISTRICTS.

With the Kansas Commission financed on a permanent basis, it is recommended that the Kansas Water Commission be granted specific authority to approve all plans and have general supervision of all construction work of drainage districts established after June 30, 1919, in accordance with the provisions of section 4 of the Water Commission act (see page 8). This procedure, which is in accord with the jurisdiction the State Highway Commission has over local highway matters, should enable the plans of the new drainage districts to conform to the general plans that may be adopted by the commission.

LEGISLATION FOR PARTIAL FLOOD RELIEF DESIRABLE.

There is urgent need for legislative action to alleviate the loss and damage to growing crops through overflow of fertile river bottom lands in the smaller valleys of Kansas. River banks of such streams as the Marais des Cygnes, Neosho, Cottonwood and Verdigris rivers are heavily overgrown with trees and brush that reduce the effective channels during moderate stages, and are at all times effective in increasing the drift problem and the resulting hazard.

The Kansas Water Commission recommends that this matter be given careful consideration by the legislature of 1919, and that legislation be enacted providing ways and means for the clearing of river banks and river channels in eastern Kansas as an immediate and partial relief measure.

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1919-1920



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SECOND BIENNIAL REPORT

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KANSAS

WATER COMMISSION

1919-1920



PREPARED IN CO-OPERATION WITH UNITED
STATES GEOLOGICAL SURVEY

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KANSAS WATER COMMISSION.

COMMISSIONERS.

HENRY J. ALLEN, *ex-officio* Chairman.

T. J. STRICKLER, Topeka. H. A. RICE, *Secretary*, Lawrence.

H. B. WALKER, *Engineer*, Manhattan.

COOPERATION WITH UNITED STATES GEOLOGICAL
SURVEY.

GEORGE OTIS SMITH, *Director*.

NATHAN C. GROVER, *Chief Hydraulic Engineer*.

ROGER C. RICE, *District Engineer*.

DISTRICT OFFICE: 23 Federal Building, Topeka.

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LETTER OF TRANSMITTAL.

TOPEKA, KAN., December 14, 1920.

Hon. Henry J. Allen, Governor:

SIR—Submitted herewith is the second biennial report of the Kansas Water Commission for 1919 and 1920.

The Kansas Water Commission has made a study of the present state laws relating to floods, drainage, domestic water supply, water power, irrigation and navigation, in accordance with section 7 of the Water Commission act, which states:

“SEC. 7. The Commission shall study the laws of the state relating to floods, drainage and irrigation, with a view to making such revisions as may be necessary to accomplish the ends prescribed in this act, and they shall report the results of their investigation and make such recommendations as they may deem proper to the legislature from time to time.”

The Water Commission recommends the following revision of the water laws: (1) Changes to correlate the jurisdiction of certain state departments whose duties are closely related, to enable them to perform greater service with less duplication of overhead expense; (2) changes to provide for state inspection and approval of engineering plans for the regulation of uncontrolled flood waters and for the drainage of overflowed lands within townships, counties, cities and drainage districts; to strengthen and extend coöperation between the state and local organizations engaged in the control and utilization of the water resources, in order that these organizations may function more effectively.

The outline accompanying this report, proposing a Division of Water Resources, to be created within the Court of Industrial Relations, embodies the recommendations of the Water Commission and is summarized as follows:

1. That a Division of Water Resources be created within the Court of Industrial Relations, with power to administer laws relating to the investigation and utilization of the water resources of the state.

2. That the duties of the Water Commission be merged with this new department and the Water Commission be abolished.

3. That the duties of the state irrigation commissioner be merged with this new department, and the Division of Irrigation in the Board of Agriculture be abolished.

4. That the Court of Industrial Relations, through the Division of Water Resources, administer the "sand law."

5. That the revenues received by the state from sand royalties through the administration of the "sand law" be appropriated to the use of the Division of Water Resources, Court of Industrial Relations.

Very respectfully,

KANSAS WATER COMMISSION.

By H. A. RICE, *Secretary*.

SECOND BIENNIAL REPORT. 1919-1920.

THE KANSAS WATER COMMISSION ACT.

Chapter 172, Session Laws of Kansas, 1917 (page 218).

AN ACT relating to floods, drainage, water power, domestic water supply, navigation, irrigation, and providing for state control of all matters relating thereto, and providing for a Water Commission in the state of Kansas.

Be it enacted by the Legislature of the State of Kansas:

SECTION 1. A commission, which shall be known as the Kansas Water Commission, is hereby created for the purpose of investigating and controlling the problems of flood prevention, drainage, domestic water supply, water power, navigation and irrigation in the state of Kansas. But said Commission shall not interfere with any drainage system now established in drainage districts created under existing laws.

SEC. 2. The Kansas Water Commission shall be composed of three persons, of which the governor shall be *ex-officio* chairman, and two civil engineers, who shall be, or qualified to be, at least associate members of the American Society of Civil Engineers, and shall be appointed by the governor to hold office for four years, or until their successors are appointed and qualified, and who shall be eligible for reappointment, and may be removed at any time by the governor for cause only. As soon as this act shall be in force the governor shall appoint one member whose term of office shall expire January 1, 1921, and one member whose term shall expire January 1, 1919; thereafter the governor shall appoint one member on the first day of January in each odd-numbered year, and whose term of office shall expire on the first day of January four years thereafter. The members of said Commission shall serve without salary or other compensation, but the members thereof shall be allowed their actual traveling expenses when on official business of the Commission. Employees of the state may be appointed members of this Commission without vacating their positions or without change of compensation.

SEC. 3. This Commission is hereby authorized to secure such expert assistance, clerical and other help, and at such compensation as may be necessary to properly carry out the provisions of this act.

SEC. 4. As soon as practical after organization, the Commission shall, in conjunction with the federal government, by way of securing financial and professional aid and assistance, work out a systematic general plan for the complete development of each watershed in the state in order to secure the most advantageous adjustment of the interest involved in matters of floods, drainage, irrigation, water power and navigation.

Where any department of the federal government is now or hereafter may be engaged in the development of plans effecting any of the subjects referred to in this act this Commission may coöperate with such federal department. Water development of all kinds throughout the state shall conform to the general plans adopted by the Commission.

SEC. 5. This Commission is hereby authorized and directed to establish and maintain river gauging stations and to make such surveys and other investigations as may be necessary to a complete knowledge of the subjects herein assigned to it for investigation.

SEC. 6. The following principles shall guide the Commission in its decisions and plans: (a) Surface or underground waters of the state may be appropriated by the federal government by civic decisions, by corporations, and by individuals upon application to the Commission, and in accordance with the rules and regulations it may prescribe. Such appropriations shall not constitute absolute ownership of such waters, but shall remain subject to the principle of beneficial use. (b) Where appropriations of water for different purposes conflict they shall take precedence in the following order, namely: domestic and transportation water supply, irrigation, industrial uses, water power. In each of these decisions prior application is to govern in making allotments. (c) Appropriation in excess of the reasonable needs of the appropriators not to be allowed. (d) Waters appropriated for irrigation are to become appurtenant to the lands to which they are applied, and underground waters for all purposes to become appurtenant to the lands under which they flow.

SEC. 7. The commission shall study the laws of the state relating to floods, drainage and irrigation, with a view to making such revisions as may be necessary to accomplish the ends prescribed in this act, and they shall report the results of their investigation and make such recommendations as they may deem proper to the legislature from time to time.

SEC. 8. The Commission and its agents shall have the power of entry on private lands for the purpose of carrying out the provisions of this act.

* SEC. 9. *All money now in the state treasury received from, or that may hereafter be received as compensation for sand taken from any navigable stream, except such amounts as drainage districts may be entitled to under the law, shall be placed in a separate fund, which shall be known as the Water Commission fund, and from which fund all expenses and obligations of the Water Commission shall be paid.*

SEC. 10. The salaries of all employees of the Water Commission shall be fixed by said Water Commission.

SEC. 12. This act shall take effect and be in force from and after its publication in the official state paper.

Approved March 13, 1917.

Published in official state paper March 24, 1917.

* Section 9 was repealed by section 4, chapter 291, Session Laws of 1919. Section 11 made appropriation for fiscal years 1917, 1918 and 1919.

FLOODS IN KANSAS.

Occasional heavy floods have occurred in the valleys of eastern Kansas at infrequent intervals since 1844, and have been the subject of much investigation by various Federal and state organizations.

In 1916 the War Department was authorized to make an investigation of the flood situation in Kansas; by authorization in the river and harbor act, approved July 27 1916:

"State of Kansas, floods in: Investigate the flood periods of the Kansas river and its tributaries, the Cottonwood and Neosho rivers, in the state of Kansas, by an examination of the territory and from data already gathered by governmental, state, private efforts, and by the Board of Engineers of the War Department, and to devise some general plan which will best guard against the recurrence of floods and diminish their damaging effects upon the lower valleys of the Kansas, Arkansas, Missouri, and the Mississippi rivers."¹

Col. C. McD. Townsend, under whose direction the work was carried on, reported in part the following recommendations:²

"I have, therefore, to report that before a general plan can be devised which will best guard against the recurrence of floods and diminish their damaging effects upon the lower valleys of the Kansas, Arkansas, Missouri and Mississippi rivers a further survey is necessary to determine the land in Kansas that is overflowed and the proper location for the works proposed to diminish the overflow, that further observation should be made to determine both the volume of flow and the maximum rate of discharge of the various rivers and the amount of sediment they carry. The work is considered of sufficient national importance to warrant the making of such a survey by the Federal government. The peculiar wording of the paragraph in the act (authorizing the investigations by the War Department) raises however, the question whether such a survey is contemplated by the act, or action should be limited to a personal examination of the territory and such data as has already been gathered. Attention is also invited to the fact that in making the necessary supplementary discharge and sedimentary observations state agencies, possibly under Federal supervision, are best adapted to this work. Discharge measurements at flood stages are essential, and as floods occur at unknown intervals and are of limited duration, an agency residing at or near the locality where the observations are to be made can act with much more certainty than one at a distance. State coöperation in such surveys appears, therefore, both proper and desirable."

P. M. Churchill, assistant engineer, made the following recommendations in his report:³

"In view of the importance of Kansas and Neosho rivers to the lives and welfare of the people of Kansas, of the fact that these are interstate streams and are legally now under the authority of the Secretary of War, and of the fact of the probable important influence which these floods exert on navigation on the Missouri and Mississippi rivers it is recommended:

(a) That a very careful and thorough reconnoissance investigation be made of the entire watersheds of these streams and of their influence on all navigable waters below, to the end that a systematic plan may be worked out for flood protection on these streams this plan to also consider all other uses to which the water of these streams may be put.

1. Floods in Kansas, H. Doc. No. 321, 65th Cong., 1st Sess.

2. *Idem*, p. 14.

3. *Idem*, p. 30.

(b) That this investigation be made contingent upon action by the state of Kansas providing for the coöperation by the state in this work, and such revision of the state water laws as will bring them into harmony with and make possible the adoption and execution of such plans as the department may, through this investigation, develop."

The investigations carried on by the Kansas Water Commission since 1917 have been in accord with the recommendations of Colonel Townsend and Mr. Churchill, although limited funds have of necessity restricted their scope.

SUMMARY OF FLOOD LOSSES FOR PERIOD 1903-1915.⁴

Kaw Valley:	Estimated flood losses.
1903	\$22,000,000
1908	3,000,000
1915	12,000,000
	\$37,000,000
Other minor floods	3,000,000
Total	\$40,000,000
Arkansas valley	\$1,500,000
Neosho valley	5,500,000
Other valleys	3,500,000
Total property loss	\$50,000,000

It appears that the period 1903-1915 was one of unusual general flood conditions and that it is not probable there will be a repetition of such heavy losses.

The extent of the flood problem in Kansas is as follows:

First: More than 2 per cent of the state's total area is subject to overflow. This area is the best located and most productive of the agricultural land in the state.

Second: 143 cities and villages of the state, representing one-fourth of the state's total population, are directly affected by floods. These cities include six of the ten first-class cities of the state and thirty-three of the seventy-five second-class cities.

Third: 13.4 per cent of the entire railroad mileage of the state is located in the overflow area.

Fourth: More than 3 per cent of the public roads of the state are subject to overflow.

Fifth: Kansas has sustained a total property loss by floods in thirteen years amounting to approximately \$50,500,000.

4. Abstracted from "The need of a comprehensive flood protection system for Kansas," by H. B. Walker, drainage and irrigation engineer, Kansas State Agricultural College, Manhattan, Kan.

HYDROMETRIC INVESTIGATIONS IN KANSAS SINCE JUNE 1, 1917.

By ROGER C. RICE, District Engineer, U. S. Geological Survey.

On May 11, 1917, a coöperative agreement was entered into between the United States Geological Survey and the Kansas Water Commission for an investigation of the water resources of Kansas. The Geological Survey established a district office in the Federal Building at Topeka on June 1, 1917.

The following appropriations have financed the investigations during the fiscal years 1917 to 1921, inclusive:

	<i>Kansas Water Commission.</i>	<i>United States Geological Survey.</i>	<i>Totals.</i>
Balance of fiscal year 1917.....	\$1,000	\$244	\$1,244
Fiscal year ending June 30, 1918.....	3,000	2,620	5,620
Fiscal year ending June 30, 1919.....	3,000 }		
Balance of fiscal year, 1919.....	1,000 }	2,500	6,500
Fiscal year ending June 30, 1920.....	5,000	3,550	8,550
Fiscal year ending June 30, 1921.....	5,000	4,000	9,000
Total for period, 1917-1921	\$18,000	\$12,914	\$30,914

RESULTS ACCOMPLISHED.

The limited funds for carrying on the investigations specified in the Water Commission act made it necessary at the outset to restrict the work chiefly to the establishment and maintenance of stream-flow measuring stations, located principally in the Kaw valley where greatest flood damage occurs. Concentration of the investigations has resulted in a more efficient handling of the field work than would otherwise be possible by the small organization, and the securing of much valuable data on the flow and channel capacities of some of the worst flood-producing streams in eastern Kansas.

During the field seasons of 1917, 1918, 1919 and 1920, many stream-flow measurements were made at these gaging stations at low, medium and high stages, to define the relation between the stage and the discharge or channel capacity. Computations of daily discharge for most of these stations have been prepared, showing the variation and amount of flow during the periods of drought and high water. These data will be published in the annual progress reports of the United States Geological Survey.

The state printer is now publishing a report for the Kansas Water Commission entitled "Surface Waters of Kansas," which is a compilation of all available United States Geological Survey stream-flow data for Kansas since 1895, together with all the available United States Weather Bureau river-stage data, and a summary of rainfall statistics for Kansas. This report contains valuable hydrometric data and descriptive matter relative to the drainage basins in the state, and will be of great value to engineers and others who have to deal with engineering and economic problems relating to the water resources of Kansas.

PRACTICAL VALUE OF THE WORK.

FLOOD-FORECAST SERVICE OF U. S. WEATHER BUREAU.

The data secured by the United States Geological Survey and the Kansas Water Commission from the gaging stations in the Kaw valley have been utilized by the United States Weather Bureau at Topeka to effect a reorganization of its flood-forecast service for Kaw valley. The gaging stations now form integral parts of this important service during the flood season, and the gage observers are under instructions to keep the Weather Bureau at Topeka informed whenever the river reaches or exceeds critical stages previously determined. The United States Weather Bureau now depends in a large measure on the continuance and normal expansion of these gaging investigations to furnish information bearing on the improvement of the flood-forecast service.

FLOOD PROTECTION.

The Kaw Valley Drainage District at Kansas City, Kan., has undoubtedly experienced as great a need for reliable information on the flow and channel capacities of Kansas rivers as any other of the many drainage districts organized since 1905.

The investigation by the Kansas Water Commission and the United States Geological Survey of the flood problem at Kansas City, Kan.,⁵ made during the summer of 1917 brought out clearly the need for an intensive study of stream-flow and channel capacities in the Kaw valley, especially within the drainage district.

WATER SUPPLY, SEWAGE DISPOSAL AND STREAM POLLUTION.

During the summer of 1917 and 1918 many cities in Kansas dependent for their water supply on surface flow of streams experienced an acute water shortage. Cities such as Ottawa, on the Marais des Cygnes river, have since made plans for increasing their water supply by means of storage dams. Controversies have arisen from time to time as to the effect of such dams on the flood situation, and much litigation has arisen. The absence of reliable stream-flow data bearing on the channel capacity at various stages, and especially at or near bank-full stage, has occasioned considerable difference of opinion in the presentation of plans for relief. Long-time records of stream-flow covering periods of high water and drought at various points in these smaller valleys of the state would be of great value and assistance to municipalities, drainage districts and other civic bodies in the solution of their water-supply, sewage-disposal and stream-pollution problems. Such records are frequently of great assistance at law in establishing statements of fact bearing on the adjudication of water rights.

Five consulting engineering firms were engaged by the city of Topeka during 1920 to study the water problems of that city and to formulate plans to supply Topeka with an adequate water supply for domestic use and for fire protection. These firms made full use of the long-time records

5. The effect of obstruction to navigation and flood prevention by the Kansas City Northwestern Railway Company's bridge on the Kansas river at Kansas City, Kan. Preliminary report by the Kansas Water Commission, August, 1917.

of low-water flow on the Kansas river that were specially compiled for their use by the United States Geological Survey, covering a period of twenty-nine consecutive years, 1891-1919. The records showed conclusively the dependability of the Kansas river as a source of water supply, provided suitable filtration works were constructed.

IRRIGATION IN ARKANSAS VALLEY IN KANSAS.

The utilization of the waters of the Arkansas river for irrigation in Colorado and in western Kansas has long since been accompanied by much expensive litigation between the water users of the two states.

Through the state engineer of Colorado, complete records of the flow of the Arkansas river in Colorado, together with complete records of all diversions, have been secured for several years. The hydrometric investigations form part of the work of the state engineer's department.

In Kansas no official records of the flow of the Arkansas river have been secured since 1906, when the United States Geological Survey discontinued its investigations, and no complete records have been obtained showing the amount of water diverted by the Kansas ditches. In the summer of 1920 the irrigation commissioner for Kansas established a river gage on the Arkansas river at Coolidge. At his request, on July 12, 1920, a discharge measurement was made by the United States Geological Survey, but no attempt has been made to secure sufficient measurements to obtain the daily discharge.

In the adjudication of pending suits involving the water rights of water users in Kansas and Colorado authentic records of the flow of the Arkansas river and the diversions by the Kansas ditches would be of vital importance. If a settlement be reached between Kansas and Colorado on a water basis, such authentic records would continue to be of vital importance in the development of irrigation in this valley.

Many discharge measurements are required to secure reliable daily flow on the Arkansas river and the Kansas ditches, owing to the shifting nature of the channels and the intermittent flow. In order to maintain the proposed gaging stations in an efficient manner it will be necessary to establish a sub-office in this area, from which the field engineer will operate, covering the territory with the aid of an automobile. The scope of the original investigations may be extended from time to time to include other irrigation problems.

PROPOSED EXTENSION OF STREAM-GAGING INVESTIGATIONS.

To meet the urgent demands for reliable hydrometric data on streams in the smaller valleys of eastern Kansas—the Marais des Cygnes, Marmaton, Neosho and Verdigris rivers—and to secure reliable stream-flow data on the utilization of the waters of the Arkansas river near the Kansas-Colorado state line for use in the adjudication of the water rights of this stream, the Kansas Water Commission and the United States Geological Survey plan a limited extension of the stream-gaging investigations during the fiscal years 1922 and 1923, in accordance with the provisions of the Kansas Water Commission act. The list of gaging stations will then be as given below:

STREAM-FLOW MEASURING STATIONS IN KANSAS.

Showing those already established and those to be established during fiscal years 1922 and 1923.

NOTE.—Stations marked thus (*) to be established.

KAW VALLEY.

<i>River.</i>	<i>Location of station.</i>	<i>County.</i>	<i>Date established.</i>
Republican river	Scandia	Republic	Aug. 27, 1919
Republican river	Wakefield	Clay	June 21, 1917
Kansas river	Ogden	Riley	June 19, 1917
Kansas river	Wamego	Pottawatomie	April 30, 1919
Kansas river	Topeka	Shawnee	June 12, 1917
Kansas river	Bonner Springs	Wyandotte	July 8, 1917
Smoky Hill river	Ellsworth	Ellsworth	July 23, 1918
Smoky Hill river	Assaria*	Saline	
Smoky Hill river	Abilene	Dickinson	June 19, 1918
Ladder creek	North of Scott City,*	Logan	
Saline river	Tescott	Ottawa	Sept. 3, 1919
Solomon river	Niles	Ottawa	May 15, 1919
Solomon river, North fork	Kirwin	Phillips	Aug. 30, 1919
Solomon river, South fork	Alton	Osborne	Aug. 31, 1919
Big Blue river	Hull	Marshall	Aug. 24, 1919
Big Blue river	Randolph	Riley	April 16, 1918
Little Blue river	Waterville*	Marshall	

MARAIS DES CYGNES VALLEY.

Marais des Cygnes river	Ottawa	Franklin	Oct. 26, 1918
Marais des Cygnes river	La Cygne*	Linn	
Marmaton river	Fort Scott*	Bourbon	

NEOSHO VALLEY.

Neosho river	Emporia*	Lyon	
Neosho river	Iola	Allen	Oct. 12, 1917
Neosho river	Oswego*	Labette	
Cottonwood river	Elmdale*	Chase	

VERDIGRIS VALLEY.

Verdigris river	Toronto*	Woodson	
Verdigris river	Independence*	Montgomery	
Fall river	Neodesha*	Wilson	
Elk river	Independence*	Montgomery	

ARKANSAS VALLEY.

Arkansas river	Syracuse*	Hamilton	
Amazon ditch	Headworks*	Kearny	
South Side ditch	Headworks*	Kearny	
Great Eastern ditch	Headworks*	Kearny	
Farmers' ditch	Headworks*	Kearny	
Garden City ditch	Headworks*	Finney	
Little Arkansas river	Sedgwick*	Harvey	

DRAINAGE-DISTRICT CORPORATIONS.

By H. B. WALKER, Engineer, Kansas Water Commission.

It is believed that the existing drainage laws of the state could be improved by suitable amendments which would invest in some state authority the right to regulate and fix certain fundamental principles in the establishment and construction of reclamation works. The fixing of these principles should be for the primary purpose of securing the most advantageous adjustment in matters of flood protection, drainage, domestic water supply, water power, irrigation, public health, transportation, etc. Such regulatory measures would not in any way interfere with the local administration of an incorporated district, but would, on the other hand, give force to all reasonable requirements made necessary by putting into execution a comprehensive and logical plan of drainage and flood protection.

LOGICAL UNITS.

If our drainage districts are to reclaim land efficiently it is evident, first of all, that the incorporated area should constitute a logical drainage unit. The present form of our Kansas drainage-district laws does not absolutely insure that the petitioners will select a logical drainage unit for a district. However, the methods of procedure in organization as outlined by the various laws are such as to render improbable any serious violations of this principle. As a rule the petitioners seeking relief exercise common sense in fixing boundaries which require but little adjustment to establish logical drainage units. No doubt, however, our present methods could be improved if officials vested with the authority of granting drainage-district corporations could call to their assistance, when needed, the proper state official to advise and consult with them upon the general problems involved before making final decisions.

COMPREHENSIVE PLANS.

A comprehensive plan must be worked out for every incorporated drainage district. A logical unit for drainage may be unsuccessfully reclaimed if the plan adopted has not been prepared upon sound engineering principles. Experience in the preparation of plans for drainage districts in this state would indicate that there is a frequent tendency for districts to undertake works of reclamation without first making proper and complete studies of the reclamation problem.

STATE APPROVAL.

A drainage district is a public corporation established under the laws of the state for the public health, convenience and welfare of a community. Therefore, it seems that it should be the duty of the state to require such corporations to file complete and specific plans and specifications for any work to be undertaken within the incorporate area. No work of construction should be permitted within the district, for which bonds are to be sold in payment for the work, until such plans and specifications have been thoroughly inspected and approved by a proper state authority. If such requirements were necessary by law a more thorough study would be made of reclamation problems before plans were adopted, which in itself would insure the public of more adequate systems of drainage. State regulation and approval would permit of a more thorough correlation of the drainage and flood-protection problems in the various drainage basins, and the plans when approved by the state would have a greater economic value to those districts where bonds must be issued to pay for the improvements.

OFFICIAL RECORDS.

Kansas needs a record of her reclamation development. Under our present laws the records of drainage improvements are scattered, and not infrequently lost with changes in local administration. Every established project required some engineering study, and all information of this nature is valuable to the state in making future comprehensive studies of water problems. With our growth in population our problems

in flood protection and drainage become more complex and important. The state should fortify itself in meeting our future problems by keeping accurate records of all work completed under the laws of Kansas.

STREAM-GAGING IMPORTANT.

In addition, the state should continue to maintain stream-gaging stations to collect and record flow data on all the principal watercourses of the state. This information is the very essence of fact upon which the future policies of the state must be developed in all water problems. Long and continuous records are essential. Without these records the state can never attack its water problems intelligently.

ORGANIZED DISTRICTS.

The best information available indicates that Kansas has forty drainage-district corporations, with a total area of 170,000 acres, including 17,000 taxpayers, and that to date \$3,000,000 have been invested.

SUMMARY.

It is evident from these facts that at least two of the drainage-district laws have been found of value in solving local drainage problems. The fact that these districts have issued several millions of dollars in bonds precludes any possibility of repealing these measures. Moreover, time has shown that the 1905 law and the May, 1911, law are practical measures for coöperative community projects. At any rate, Kansas has not made a sufficient study of the state's reclamation problems to offer anything better at this time. The more important policy appears to be to improve our existing, time-tried laws and for the state to continue to make more detailed studies of our water problems for the purpose of securing the most advantageous adjustment of the interest involved in matters of floods, drainage, irrigation, water power, public health and transportation. With this policy in mind, it is believed that our existing drainage laws should be improved by amendments for the following purposes:

(a) To make state engineering advice available to officers vested with the authority to establish drainage districts.

(b) To require the approval by state authority of all plans, specifications, estimates and reports of projects where bonds are sold in payment of the work.

(c) To require the filing for public record of all official plats, plans, specifications, estimates and reports with a proper state official.

USE OF WATER FOR IRRIGATION.

By H. B. WALKER, Engineer, Kansas Water Commission.

THE RIGHT TO USE WATER.

The Kansas legislature of 1886 passed a law for the appropriation of water for irrigation purposes. Since that time numerous laws have been enacted relating to irrigation, yet our method of appropriating water has changed but little during the past thirty-four years. Appropriators desiring water need only to post a notice at the point of diversion, stating therein that the person, company or corporation claims the water flowing to the extent of so many cubic feet per second. Such notice shall also describe and define the point of diversion and shall state in general terms the method by which water is to be diverted. A copy of this notice must likewise be posted in the office of the county clerk of the county in which place of diversion is situated, and finally the record of appropriation is filed in the office of the register of deeds of that county.

KANSAS METHOD OBSOLETE.

The Kansas method of appropriating water is obsolete and subject to many inaccuracies of record. Only one other state in the Union has a similar method of appropriation. This is the state of Montana. All other irrigation states require water rights to be granted by some central authority, which results in more accurate and uniform records and a better-guarded and more valuable water right. Water is a natural resource having a definite value to the state. Kansas surely recognized this when it passed a law outlining a method by which water could be appropriated for use in irrigation. Those who have taken advantage of the opportunity to use this water are developing one of the state's natural resources, and in doing this they are surely entitled to the full protection of the law in their development.

DISADVANTAGES OF KANSAS METHOD.

The Kansas method of appropriating water does not permit of uniformity either in method or in quantities of water appropriated. Individuals may use their own personal method of making application, so long as they post notices at the proper places and insert some figure therein to indicate the approximate quantity of water desired and the general method and place of diversion. No one with proper authority or knowledge checks the application, and since it is the duty of the register of deeds to keep only a record of the appropriation, he is not interested in the quantity of water claimed.

After an appropriation for water has been made, our laws do not provide a definite method of proof as a final claim to the water right. While it is required that work must begin upon the project within a certain time, no provision is made for a proper state official with authority to determine or record this fact. The whole outcome is a set of water records filed in the office of the register of deeds, which are in many cases of

doubtful value. Should any loan association, company or citizen desire to inspect the records of the water filings on any particular stream of the state, to determine the amount, priorities or value thereof, it would be necessary for that company or person to make an inspection of the filings in the office of the register of deeds in the various counties through which the stream passes. A review of such records would undoubtedly show a large variation in the method of filing and quantities appropriated, and, moreover, such investigations would be expensive and of doubtful value to the investigator. The laws of Kansas, while permitting citizens to use water for irrigation in aid of agriculture, do not provide adequate legal records to make the appropriation, when secured, of any particular economic value to the appropriator.

UNIFORM FILING SYSTEM NEEDED.

As a remedy for this obsolete method, it is recommended that our present irrigation laws be amended to require all applications for water rights to be made at some central state office. Such an office should be directed by some competent engineer, whose duty it would be to examine carefully all such applications for the purpose of determining whether or not the quantity of water requested was actually available and unappropriated from the stream, and further, whether or not the amount claimed could be beneficially applied to the area to be irrigated. If after such an investigation the application is granted, a careful record should then be prepared and filed in the central office. A further duty of such an official should be the inspection of projects for which appropriations have been granted to determine if the water right was actually being developed as required by law.

A KANSAS WATER CODE.

In 1891 important irrigation laws were passed which applied to that part of Kansas situated west of the ninety-ninth meridian. These laws relate to the use of water, whether surface or subterranean, and outline a code for the use of such water, stating that such waters shall be devoted, first, to purposes of irrigation in aid of agriculture, subject to ordinary domestic uses; and secondly, to other industrial purposes; and may be diverted from natural beds, basins or channels for such purposes and uses, provided that no such diversion shall interfere with, diminish or divest any prior vested right or appropriation without the due legal condemnation of and compensation for the same. Such a water code is desirable for the entire state of Kansas. This same law of 1891, as amended by law of 1911, made all waters flowing in subterranean channels and courses, or flowing or standing in subterranean sheets or lakes, appurtenant to the lands through which they flow or stand, with the same general code for the use of such water as outlined in the sentence above. This law, however, applied only to that part of Kansas situated west of the ninety-ninth meridian and south of township 18. It seems logical that all subterranean water should be appurtenant to the land under which such waters are situated, and it is believed that the law should

apply to all sections of the state. Ground water is perhaps the greatest available supply of water for irrigation. If utilized it must be pumped, and there is little possibility of waste from this method of irrigation.

FURTHER STUDIES DESIRABLE.

While Kansas has many other laws relating to irrigation, the other general laws are not of such fundamental concern to the irrigation interests of the state at this time. Many of these laws are undoubtedly useless and others need revision; still no definite constructive recommendations can be made until further studies are made.

STREAM GAGING ESSENTIAL.

Naturally, any logical regulation and control of irrigation development must be based upon fundamental hydraulic data. Records of stream flow for all Kansas streams are needed for this purpose. The work of the Kansas Water Commission, in coöperation with the United States Geological Survey, in stream-gaging work, should be extended to include all of the streams of the state. Furthermore, records should be kept of the quantity of water diverted from Kansas streams for purposes of irrigation. These fundamental investigations are of great importance in the logical development of the water resources of Kansas.

IRRIGATION A PART OF A KANSAS WATER PROGRAM.

Kansas must recognize that her waters for irrigation are important as a natural resource. In formulating a state water policy the work of the state irrigation commissioner should be combined with the activities of the other branches of the state government now charged with hydraulic duties, so that a comprehensive and logical irrigation policy can be developed as a part of the state water policy. In this respect the state should recognize the rights of its citizens in the use of water from interstate streams as against the rights of citizens in adjoining states who may claim priority of right over the rights of our own taxpayers.

SUMMARY.

The following recommendations for changes in our irrigation laws are suggested:

First. Change the method of filing and recording water rights from the county plan to a central state-office plan.

Second. Adopt a water code for the entire state as now apply to that section of Kansas west of the ninety-ninth meridian.

Third. Make underground waters appurtenant to all lands of the state, with a definite water code for the use of such waters.

Fourth. Combine the state irrigation activities with other state water departments for the purpose of developing a comprehensive and logical irrigation policy.

BUDGET FOR FISCAL YEARS 1922 AND 1923.

	1922	1923
(a) To provide for a Division of Water Resources, Court of Industrial Relations, and for engineering investigations and reports to the Court of Industrial Relations in all matters relating to the utilization of the water resources of Kansas:		
Hydraulic engineer, in charge of Division of Water Resources....	\$4,000	\$4,000
Assistant hydraulic engineer, to be detailed on irrigation investigations*	3,500	3,500
Assistant engineer*	2,500	2,500
Secretary, clerk-stenographer	1,500	1,500
Office furniture and equipment	400	100
Contingent fund for traveling expenses, office expenses, miscellaneous printing and filing, etc.	2,100	2,400
	<u>\$14,000</u>	<u>\$14,000</u>
(b) For hydrometric investigations in cooperation with the United States Geological Survey, providing for an organization for stream gaging, operation and maintenance of stream-flow measuring stations, establishment of new stations, and for special investigations:		
Assistant engineer	\$2,400	\$2,400
Junior engineer	1,800	1,980
Junior engineer .....	.....	1,800
Clerk-stenographer	1,380	1,500
	<u>\$5,580</u>	<u>\$7,680</u>
Operation and maintenance of present 16 stream-flow measuring stations:		
Gage observers, 16 × \$7.50 × 12	\$1,440	\$1,440
Field expenses, 16 × \$50	800	800
Maintenance of gaging stations, 16 × \$15	240	240
	<u>\$2,480</u>	<u>\$2,480</u>
Construction and establishment of 19 new stream-flow measuring stations, as follows:		
Kaw valley:		
1. Smoky Hill river, Assaria	\$100	.....
2. Ladder creek, Scott City	100	.....
3. Little Blue river, Waterville†	1,500	.....
	<u>\$1,700</u>	<u>.....</u>
Marais des Cygnes valley:		
4. Marais des Cygnes river, La Cygne .....	.....	\$200
5. Marmaton river, Fort Scott† .....	.....	1,500
	.....	<u>\$1,700</u>
Neosho valley:		
6. Neosho river, Emporia	\$100	.....
7. Neosho river, Oswego	100	.....
8. Cottonwood river, Elmdale	100	.....
	<u>\$300</u>	<u>.....</u>
Verdigris valley:		
9. Verdigris river, Toronto	\$100	.....
10. Verdigris river, Independence†	2,000	.....
11. Fall river, Neodesha	100	.....
12. Elk river, Independence	100	.....
	<u>\$2,300</u>	<u>.....</u>
Arkansas valley:		
13. Arkansas river, Syracuse†	\$400	.....
14. Amazon ditch, Headworks†	250	.....
15. South Side ditch, Headworks†	250	.....
16. Great Eastern ditch, Headworks†	250	.....
17. Farmers ditch, Headworks†	250	.....
18. Garden City ditch, Headworks†	250	.....
19. Little Arkansas river, Sedgwick	100	.....
	<u>\$1,750</u>	<u>.....</u>

	1922	1923
Operation and maintenance of 19 new stream-flow measuring stations:		
Gage observers, 19 × \$7.50 × 6	\$855	.....
Gage observers, 19 × \$7.50 × 12		\$1,710
Field expenses, 19 × \$25	475	.....
Field expenses, 19 × \$50		950
Maintenance of gaging stations, 19 × \$15		285
	<u>\$1,330</u>	<u>\$2,945</u>
Equipping sub-office, Garden City	\$75	.....
Storage of Ford car at Topeka, \$8 × 12	96	\$96
Storage of Ford car at Garden City, \$6 × 12	72	72
Automobile maintenance of Ford car, eastern Kansas	100	100
Automobile maintenance of Ford car, western Kansas	100	100
Telephone service, Topeka, \$6 × 12	72	72
Supplies and equipment	45	300
Contingent		455
	<u>\$560</u>	<u>\$1,195</u>
Totals	\$30,000	\$30,000

* These engineers included on the budget in order to continue the work of the Division of Irrigation now within the Board of Agriculture, but with added duties.

† Stations to be equipped with continuous water-stage records.

NOTE.—Through the cooperation with the United States Geological Survey, the Division of Water Resources, Court of Industrial Relations, secures the following federal assistance: United States Geological Survey furnishes headquarters in the Federal Building at Topeka, and possibly in the Federal Building at Garden City; the extension of the franking privilege for cooperative official reports; publication of results of the investigations in the regular annual reports of the Geological Survey; civil-service engineers with United States Geological Survey training and experience in hydrometric investigations, and also Federal allotments for the work, dependent upon appropriations by Congress.

DEFICIENCY APPROPRIATION FOR THE BALANCE OF THE FISCAL YEAR 1920.

The following deficiency appropriation for the balance of the fiscal year 1920 is urged:

1. Field work for stream gaging	\$500
2. Reconnaissance investigations for new stream-flow measuring stations and for special investigations	300
3. Technical assistance, 4 months at \$150	600
4. Clerical assistance, 6 months at \$100	600
Total	\$2,000

These funds are needed to permit of necessary field work during the spring of 1921; for reconnaissance work prior to July 1, 1921; for the location of suitable sites for new stream-flow measuring stations to be installed after July 1, 1921, as stated in the budget for fiscal years 1922 and 1923; for special investigations; for pay of technical assistance prior to July 1, 1921, and for clerical assistance in computing and compiling data for publication and for proof-reading reports.

This deficiency appropriation will enable the present work of the Kansas Water Commission to continue uninterrupted for the balance of the fiscal year 1920, and at the same time enable the Division of Water Resources, Court of Industrial Relations, to make suitable preparations for carrying on efficiently the program of work as outlined in the budget.



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OF THE
KANSAS
WATER COMMISSION
1921-1922



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THIRD BIENNIAL REPORT

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1921-1922

Prepared in cooperation with the
UNITED STATES GEOLOGICAL SURVEY



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KANSAS WATER COMMISSION.

COMMISSIONERS.

Gov. HENRY J. ALLEN, *ex-officio* Chairman.

H. A. RICE, *Secretary*, Lawrence.

H. B. WALKER, *Engineer*, Manhattan.

UNITED STATES GEOLOGICAL SURVEY.

PERSONNEL.

GEORGE OTIS SMITH, *Director*.

NATHAN C. GROVER, *Chief Hydraulic Engineer*.

E. L. WILLIAMS, *District Engineer*.

H. B. KINNISON, *Engineer*.

OFFICE: Room 23, Federal building, Fifth and Kansas avenue, Topeka.

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LETTER OF TRANSMITTAL.

TOPEKA, KAN., November 30, 1922.

Hon. Henry J. Allen, Governor:

SIR—Submitted herewith is the third biennial report of the Kansas Water Commission for 1921 and 1922.

Your attention is called particularly to the expansion which has been made in the primary work of the Commission, the collection of stream-flow records; to the economy of operation exercised by the Commission in line with the policy of the administration; to the increasing importance of basic information relative to the various uses of water in Kansas; and to the increased use, and recognition of the importance of the basic stream-flow records being collected by the Commission.

The Commission respectfully recommends that this valuable work be continued throughout the biennium, 1924 to 1925.

Very respectfully,

KANSAS WATER COMMISSION.

By H. A. RICE, *Secretary*.

20 Apr. 23 div. g. v. 3. cont.

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THIRD BIENNIAL REPORT.

1921-1922.

INTRODUCTORY STATEMENT.

The Kansas Water Commission came into existence March 24, 1917, as the result of passage in the state legislature of

THE KANSAS WATER COMMISSION ACT.

(Chapter 172, Session Laws of Kansas, 1917, p. 218.)

AN ACT relating to floods, drainage, water power, domestic water supply, navigation, irrigation, and providing for state control of all matters relating thereto, and providing for a Water Commission of the State of Kansas.

Be it enacted by the Legislature of the State of Kansas:

SECTION 1. A commission, which shall be known as the Kansas Water Commission, is hereby created for the purpose of investigating and controlling the problems of flood prevention, drainage, domestic water supply, water power, navigation and irrigation in the state of Kansas. But said Commission shall not interfere with any drainage system now established in drainage districts created under existing laws.

SEC. 2. The Kansas Water Commission shall be composed of three persons, of which the governor shall be *ex-officio* chairman, and two civil engineers, who shall be, or qualified to be, at least associate members of the American Society of Civil Engineers, and shall be appointed by the governor to hold office for four years, or until their successors are appointed and qualified, and who shall be eligible for reappointment, and may be removed at any time by the governor for cause only. As soon as this act shall be in force the governor shall appoint one member whose term of office shall expire January 1, 1921, and one member whose term shall expire January 1, 1919; thereafter the governor shall appoint one member on the first day of January in each odd-numbered year, and whose term of office shall expire on the first day of January four years thereafter. The members of said Commission shall serve without salary or other compensation, but the members thereof shall be allowed their actual traveling expenses when on official business of the Commission. Employees of the state may be appointed members of this Commission without vacating their positions or without change of compensation.

SEC. 3. This Commission is hereby authorized to secure such expert assistance, clerical and other help, and at such compensation as may be necessary to properly carry out the provisions of this act.

SEC. 4. As soon as practical after organization the Commission shall, in conjunction with the federal government, by way of securing financial and professional aid and assistance, work out a systematic general plan for the complete development of each watershed in the state in order to secure the most advantageous adjustment of the interests involved in matters of floods, drainage, irrigation, water power and navigation. Where any department of the federal government is now or hereafter may be engaged in the development of plans effecting any of the subjects referred to in this act, this Commission may cooperate with such federal department. Water development of all kinds throughout the state shall conform to the general plans adopted by the Commission.

SEC. 5. This Commission is hereby authorized and directed to establish and maintain river gauging stations and to make such surveys and other investiga-

tions as may be necessary to a complete knowledge of the subjects herein assigned to it for investigation.

SEC. 6. The following principles shall guide the Commission in its decisions and plans: (a) Surface or underground waters of the state may be appropriated by the federal government by civic decisions, by corporations, and by individuals upon application to the Commission, and in accordance with the rules and regulations it may prescribe. Such appropriations shall not constitute absolute ownership of such waters, but shall remain subject to the principle of beneficial use. (b) Where appropriations of water for different purposes conflict they shall take precedence in the following order, namely: domestic and transportation water supply, irrigation, industrial uses, water power. In each of these decisions prior application is to govern in making allotments. (c) Appropriation in excess of the reasonable needs of the appropriators not to be allowed. (d) Waters appropriated for irrigation are to become appurtenant to the lands to which they are applied, and underground waters for all purposes to become appurtenant to the lands under which they flow.

SEC. 7. The Commission shall study the laws of the state relating to floods, drainage and irrigation, with a view to making such revisions as may be necessary to accomplish the ends prescribed in this act, and they shall report the results of their investigation and make such recommendations as they may deem proper to the legislature from time to time.

SEC. 8. The Commission and its agents shall have the power of entry on private lands for the purpose of carrying out the provisions of this act.

* SEC. 9.

SEC. 10. The salaries of all employees of the Water Commission shall be fixed by said Water Commission.

* SEC. 11.

SEC. 12. This act shall take effect and be in force from and after its publication in the official state paper.

Approved March 13, 1917.

Published in official state paper March 24, 1917.

The Kansas Water Commission is composed of the following: Hon. Henry J. Allen, Governor, *ex-officio* chairman; Prof. H. A. Rice, University of Kansas, secretary; Prof. H. B. Walker, Kansas State Agricultural College, engineer. These men serve without pay, according to the terms of the act, but are reimbursed for actual expenses when engaged in official work of the Commission.

In accordance with section 4 of the Kansas Water Commission act, the Commission started on May 11, 1917, and has continued up to the present time, coöperation with the United States Geological Survey, whereby an equivalent amount of federal funds are obtained for hydraulic investigations in Kansas, and an experienced hydraulic engineer assigned from the trained forces of the Water Resources Branch of the United States Geological Survey, thereby assuring the same standards for stream-gauging work in Kansas as obtain in other states, and the unqualified acceptance by the courts and by the leading hydraulic authorities in the country of the data collected.

Besides the direct allotment from funds at the disposal of the United States Geological Survey, there are other privileges obtained by the United States Geological Survey which are of direct financial benefit; as, the use of the

* Section 9 was repealed by section 4, chapter 291, Session Laws of 1919. Section 11 made appropriation for fiscal years 1917, 1918 and 1919.

franking privilege; office quarters furnished free by the Post-office Department; the purchase of supplies through government bureaus in Washington at reduced contract prices; the publication and distribution of the data collected by the government press, etc.

The technical conduct of stream-gauging work in Kansas is carried out by the following organization: E. L. Williams, hydraulic engineer, U. S. Geological Survey, district engineer; H. B. Kinnison, engineer, U. S. Geological Survey, in charge Topeka office; Gerritt H. Barger, junior engineer, U. S. Geological Survey, office and field assistant. Headquarters of the Commission are located in room 23, federal (post office) building, Fifth and Kansas avenue, Topeka, Kan. The quarters and office fixtures are furnished rent free through coöperation with the United States Geological Survey, and courtesy of the United States Treasury Department, and W. O. Rigby, postmaster at Topeka, Kan.

ACTIVITIES OF THE KANSAS WATER COMMISSION.

POLICY OF THE COMMISSION.

The Kansas Water Commission has consistently followed a policy looking toward the ultimate development of the water resources of the state to the greatest advantage of the largest number of the inhabitants of the state. Without a thorough knowledge of what those water resources might be, it would be folly for the Commission to attempt to lay out a policy, or promulgate regulations, relative to the appropriation and use of water, and governing the construction of all engineering works designed for the use and control of water. The Commission has considered that its recommendations and regulations should be preceded by a thorough study of the location, nature, and amount of the water resources of the state, and with this general policy in mind the Commission has decided that its immediate investigations should be made on the surface or flowing waters in the natural river channels in the state.

This course of investigation involved measuring and recording the flow of water in the streams at certain selected points over a period of years, and since the United States Geological Survey had been doing similar work over the entire country for the past twenty years, and had developed practice and methods which are accepted as standard, the Commission requested and secured the coöperation of the United States Geological Survey, and had an experienced hydraulic engineer of that department assigned to work with the Water Commission in conducting its investigations of surface-water flow in the streams in the state. This work, the measuring and recording of the volume of water flowing in streams, is technically called *stream gauging*, and the selected points on the streams where the volume of water records are collected, are called *gauging stations*.*

* A stream-gauging station consists of a staff or chain gauge, or automatic gauge, where the stage of the river is recorded every day. With this basic information, and measurements of flow, (from which is determined the actual amount of water flowing in the stream at any stage), the flow or discharge for each day in the year is computed and put on record. These records are compiled and published at the end of each year.

Measurements of flow or discharge measurements are made by suspending a Price Current meter in the water at certain points across a stream. This meter measures the speed or velocity of the current in feet per second. Soundings are made across the stream with a

Stream-gauging stations were established at certain selected sites, having in view the immediate call for and need of the records, where the conditions on the stream were satisfactory for the operation of a stream-gauging station, and where the most reliable records could be obtained at the least expense.

EXTENT OF WORK.

The immediate need for stream-gauging work was apparent when the flood of 1915 swept the Kansas river valley and caused such destruction that a cry arose from the people in the valley for protection from future floods. Realizing the pressing need for stream-flow records on the Kansas river and its tributaries, without which satisfactory protective works could not be constructed, the Commission started its investigations in this valley, and its work for two years was confined entirely to this watershed. Fourteen gauging stations have been operated in the valley for the past five years.

But the Kansas river is not the only river in the state upon which disastrous floods have occurred, and the Commission's policy has been to extend its stream-gauging operations as rapidly as the work could be done, and the funds at its disposal permit. Gauging stations were later established on the Neosho and Marais des Cygnes rivers; and during the past biennium, the work has been extended to cover most of the primary watersheds in the state.

The following is a list of gauging stations operated by the Kansas Water Commission during the biennium, 1921-1922:

ARKANSAS RIVER BASIN.

<i>Date started.</i>	<i>Name of river.</i>	<i>Nearest town.</i>	<i>County.</i>	<i>Observer.</i>
June 21, 1922.	Arkansas	Garden City ...	Finney	Ben Allen.
June 22, 1922.	Arkansas	Larned	Pawnee	Vaughn Steuart.
June 10, 1921.	Arkansas	Wichita	Sedgwick	P. L. Brockway.
Sept. 9, 1921.	Arkansas	Arkansas City ..	Cowley	F. O. Burnett.
May 9, 1922.	Cottonwood	Elmdale	Chase	Rowena Starkey.
Aug. 23, 1921.	Diversion Canal	Arkansas City ..	Cowley	F. O. Burnett.
June 10, 1922.	Little Arkansas	Valley Center ..	Sedgwick	Clarence Carr.
Oct. 12, 1917.	Neosho	Iola	Allen	Homer Teats.
Oct. 18, 1921.	Neosho	Parsons	Labette	Mrs. W. C. Slane.
Oct. 20, 1921.	Verdigris	Independence ...	Montgomery ...	Ben Wainscott.
Nov. 14, 1921.	Walnut	Winfield	Cowley	Wm. Mason.

KANSAS RIVER BASIN.

Aug. 24, 1919.	Big Blue	Hull	Marshall	James Pribyl.
April 26, 1918.	Big Blue	Randolph	Riley	Mrs. Ollie Webb.
June 17, 1922.	Delaware	Valley Falls	Jefferson	Joe Piazzek.
June 19, 1917.	Kansas	Ogden	Riley	Arthur Estes.
April 30, 1919.	Kansas	Wamego	Pottawatomie ...	U. S. Wea. Bur.
June 12, 1917.	Kansas	Topeka	Shawnee	H. N. Richardson.
June 8, 1917.	Kansas	Bonner Springs..	Wyandotte	B. L. Rehm.
June 1, 1922.	Little Blue	Waterville	Marshall	W. E. Turner.
Aug. 27, 1919.	Republican	Scandia	Republic	C. P. Nordman.
June 21, 1917.	Republican	Wakefield	Clay	S. R. Winsor.
Sept. 3, 1919.	Saline	Tescott	Ottawa	W. A. Scidmore.
July 24, 1918.	Smoky Hill	Ellsworth	Ellsworth	E. A. Forkner.
July 19, 1918.	Smoky Hill	Abilene	Dickinson	Mrs. R. A. Grubbs.
May 15, 1919.	Solomon	Niles	Ottawa	Ellsworth Boyle.
Aug. 30, 1919.	Solomon, N. Fork...	Kirwin	Phillips	Dan W. Fisk.
Aug. 31, 1919.	Solomon, S. Fork...	Alton	Osborne	J. K. Thompson.

rod or tape, and the width of the stream measured. The average velocity and average depth are then computed, and applied in the following formula:

Depth $\times$ width $\times$ velocity = discharge, or volume of water flowing in the stream.

Depth and width are measured in feet, velocity in feet per second, therefore the discharge is obtained as cubic feet per second. Cubic feet per second, or second-feet as generally expressed, is the term in general use in engineering practice in a study or discussion of the flow of a stream.

A cubic foot is equivalent to 7.48 gallons.

OSAGE RIVER BASIN.

<i>Date started.</i>	<i>Name of river.</i>	<i>Nearest town.</i>	<i>County.</i>	<i>Observer.</i>
Aug. 5, 1921.	Marmaton	Fort Scott	Bourbon	Clyde Severy.
June 17, 1922.	*Marais des Cygnes..	Quenemo	Osage	Emory Cowdin.
Oct. 26, 1918.	*Marais des Cygnes..	Ottawa	Franklin	J. M. Lewis.
Aug. 4, 1921.	*Marais des Cygnes..	Trading Post ...	Linn	J. Van Hercke.

Records for these stations may be obtained upon request from the Kansas Water Commission, 23 Federal building, Topeka, Kan.

All records prior to 1919 have been published in "Surface Waters of Kansas, 1895-1919," a copy of which may be obtained upon request from the Commission.

SPECIAL PROJECTS.

The Commission made two special investigations of water problems in the state during the biennium.

During the summer of 1921 a controversy arose at Wichita, Kan., over the removal of sand from the bed of the Arkansas river adjacent to the wells of the Wichita Water Company. This company furnishes water for the city of Wichita and it was alleged that the removal of sand from the river bed was lowering the ground water level to the extent of endangering the city's water supply. The State Executive Council requested the Water Commission to make an investigation and report. A field investigation was made under the direction of the Commission by H. B. Walker, engineer, assisted by H. B. Kinnison, engineer, U. S. Geological Survey, and George S. Knapp, state irrigation commissioner. It was the conclusion of these investigating engineers "that the pumping of sand from the bed of the Arkansas river in the city of Wichita has been the most direct contributing factor in the lowering of the stream bed elevation" . . . "and in this way causes lower ground water elevations adjacent to the deepened channel."

Definite recommendations were submitted to the State Executive Council and these were adopted and are now being carried out under the supervision of Mr. George S. Knapp, state irrigation commissioner.

Governor Allen requested the commission in August, 1922, to investigate the reconstruction of the waterpower dam operated by the Kansas Gas and Electric Company near Arkansas City, Kan. Preliminary field investigations were made by H. B. Walker, engineer for the Commission, and it was recommended that final disposition of the case should be left with the Public Utilities Commission since the dam was established under authority of an order of this Commission in 1918.

The Commission has been called upon frequently by correspondence to give advice and data concerning the development of the water resources of the state. Much valuable data have been furnished in this way. Since the members of the Commission serve without pay and are regularly engaged with other duties, it has not been possible to meet all requests for field investigations.

EXPANSION OF WORK DURING THE BIENNIUM.

During the biennium ending June 30, 1918, seven gauging stations were established.

During the biennium ending June 30, 1920, ten additional gauging stations were established, and one gauging station was discontinued.

During the biennium just past, ending June 30, 1922, fifteen additional gaug-

* Osage river by decision of the National Geographic Board.

ing stations were established, and one gauging station was discontinued. At the present time there are thirty-one gauging stations in operation.

Thus it will be seen that during the past biennium the number of points at which stream-flow data are being obtained has been doubled, and the area over which the work is being done has been extended to cover all of the state, except the extreme northwest section. This expansion of stream-gauging work has been possible only by practicing the strictest economy, since the combined state and federal appropriations for this work have been \$1,500 less per year than for the biennium ending June 30, 1921. The funds available for the present fiscal year will not be sufficient to maintain the present system of gauging stations, which have been installed and operated under larger appropriations and with the assistance of coöperative funds from private parties, and will permit no further expansion in the work, and will allow only a very small traveling and expense fund for the Commission.

COOPERATION.

In recognition of the valuable data being collected on the flow of streams, and the limited appropriations which have been available for this work in Kansas, the Commission is pleased to report an increased amount of coöperation from private companies, other federal bureaus, state departments, drainage districts, and individuals, by the furnishing of financial assistance, or by personal services.

The following is a list of coöperative parties, and the extent of their co-operation, represented either by direct payment of funds, or estimated cost of services and assistance rendered, for the fiscal year ending June 30, 1922:

Kansas Gas & Electric Co. (E. C. Curtis, engineer).....	\$400
U. S. Weather Bureau (S. D. Flora, meteorologist).....	123
City of Wichita (P. L. Brockway, city engineer).....	85
State Irrigation Commissioner (Geo. S. Knapp).....	37
Joe Piazzak, Valley Falls	3

Total private coöperation \$648

The Kansas Gas & Electric Co., coöperated in the establishment and operation of six stations; the U. S. Weather Bureau, 4; the state irrigation commissioner, 1; the city of Wichita, 1; and Joe Piazzak furnished gauge readings on the Delaware river station free of charge.

The Kaw river drainage district has completed plans and will construct two automatic gauging stations on the Kansas river at Bonner Springs and Kansas City, Kan., and will coöperate in the operation of these two stations.

The North Topeka drainage district, V. R. Parkhurst, engineer, and the South Side levee district No. 6, coöperated by constructing a concrete well and shelter for the long distance automatic gauge at Topeka. The receiver of this instrument is in the office of the U. S. Weather Bureau, New England building, where it may be seen, and where the stage of the river at Topeka is shown continuously on a graphic chart.

Franklin county and the city of Ottawa coöperated in the construction of a concrete well and shelter for the automatic gauge installation on the Marais des Cygnes river near the Seventh street bridge.

SUMMARY OF STREAM FLOW DATA IN KANSAS

For the water year ending September 30, 1920.

STATION, RIVER AND TOWN.	Average monthly discharge. Cubic feet per second.												Average cubic feet per second.	Total acre feet.
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.		
ARKANSAS RIVER BASIN: Neshio—Iola.	35.7	49.8	46.4	55.1	39.8	392.0	392.0	312.0	263.0	582.0	438.0	1,780.0	304.0	265,000
KANSAS RIVER BASIN:														
Big Blue—Hull.	855.0	610.0	302.0	402.0	775.0	325.0	992.0	798.0	704.0	576.0	611.0	323.0	605.0	439,000
Big Blue—Hull.	1,450.0	1,120.0	646.0	1,040.0	1,700.0	834.0	2,570.0	1,520.0	1,290.0	872.0	892.0	1,070.0	1,250.0	950,000
Blue—Randolph.	2,020.0	1,260.0	1,310.0	1,440.0	1,640.0	1,190.0	2,760.0	2,390.0	1,010.0	1,010.0	2,020.0	1,480.0	1,820.0	1,304,000
Kansas—Oden.	4,170.0	2,610.0	1,930.0	2,570.0	3,620.0	1,990.0	5,860.0	4,620.0	2,770.0	1,870.0	2,280.0	4,580.0	3,270.0	2,375,000
Kansas—Wamego.	4,480.0	2,760.0	2,000.0	2,500.0	3,820.0	2,400.0	6,060.0	4,970.0	3,010.0	2,620.0	2,950.0	4,960.0	3,530.0	2,566,000
Kansas—Topeka.	4,920.0	2,840.0	2,300.0	2,760.0	3,480.0	2,430.0	7,480.0	5,370.0	4,700.0	3,600.0	3,080.0	6,010.0	4,060.0	2,948,000
Kansas—Bonter Springs.	410.0	516.0	532.0	652.0	901.0	612.0	1,260.0	1,210.0	507.0	364.0	550.0	1,220.0	715.0	519,000
Republican—Scandia.	600.0	571.0	562.0	652.0	964.0	705.0	1,460.0	1,720.0	599.0	497.0	572.0	1,750.0	884.0	642,000
Republican—Waldfield.	166.0	102.0	82.9	88.5	61.1	32.9	146.0	171.0	128.0	90.9	46.0	45.3	102.0	74,200
Saltine—Escott.	107.0	107.0	81.1	115.0	74.6	56.5	75.4	108.0	65.7	34.1	56.6	55.0	88.5	54,200
Smoky Hill—Ellsworth.	1,320.0	805.0	631.0	710.0	661.0	565.0	1,000.0	1,050.0	509.0	414.0	1,050.0	875.0	802.0	582,000
Smoky Hill—Albion.	873.0	453.0	311.0	331.0	270.0	219.0	611.0	482.0	284.0	257.0	579.0	606.0	443.0	322,000
Solomon—Niles.	188.0	108.0	97.5	84.5	66.5	53.2	65.4	79.7	34.9	62.0	74.5	41.5	79.9	58,100
Solomon—North Fork—Kirwin.	209.0	143.0	136.0	110.0	88.9	69.0	105.0	149.0	87.8	19.1	112.0	36.8	106.0	76,800
Solomon—South Fork—Alton.														
Osage River Basin:														
Osage—Ottawa.	2.8	1.6	0.7	2.4	4.0	16.6	113.0	148.0	561.0	251.0	90.2	1,550.0	226.0	164,000

*Maraïs des Cygnes river near Ottawa; by decision of the National Geographic Board this river is called Osage river in all official government publications and maps.

SUMMARY OF STREAM FLOW DATA IN KANSAS.

For the water year ending September 30, 1921.

STATION, RIVER AND TOWN.	Average monthly discharge. Cubic feet per second.												Average cubic feet per second.	Total acre feet.
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.		
ARKANSAS RIVER BASIN:														
Arkansas—Wichita.	188.0	130.0	203.0	353.0	194.0	876.0	581.0	1,250.0	5,500.0	2,390.0	1,940.0	356.0	2,280.0	505,000
Arkansas—Arkansas City.												225.0	225.0	9,380
Neesho—Iola.												484.0	543.0	393,000
KANSAS RIVER BASIN:														
Big Blue—Hull.	227.0	315.0	258.0	247.0	293.0	272.0	285.0	391.0	1,080.0	1,040.0	379.0	609.0	450.0	326,000
Big Blue—Randolph.	472.0	554.0	497.0	574.0	530.0	475.0	520.0	1,050.0	1,980.0	3,960.0	863.0	766.0	1,025.0	742,000
Kansas—Ogden.	776.0	918.0	750.0	725.0	1,170.0	858.0	1,180.0	2,520.0	3,020.0	2,020.0	1,210.0	636.0	1,340.0	970,000
Kansas—Wamego.	1,180.0	1,440.0	1,360.0	1,520.0	1,670.0	1,450.0	1,710.0	4,180.0	5,670.0	6,610.0	2,390.0	1,750.0	2,590.0	1,870,000
Kansas—Topeka.	1,170.0	1,280.0	1,230.0	1,460.0	1,970.0	1,700.0	1,700.0	5,840.0	6,380.0	7,530.0	3,030.0	2,100.0	2,960.0	2,140,000
Kansas—Bonner Springs.	1,620.0	1,790.0	1,740.0	2,010.0	2,230.0	3,050.0	2,740.0	11,800.0	8,030.0	8,450.0	5,730.0	3,800.0	4,430.0	3,210,000
Republican—Scandia.	420.0	565.0	545.0	566.0	903.0	623.0	773.0	980.0	1,500.0	582.0	422.0	480.0	694.0	502,000
Republican—Wakefield.	492.0	609.0	597.0	603.0	949.0	644.0	754.0	1,250.0	1,750.0	1,160.0	416.0	365.0	797.0	577,000
Saline—Tescott.	16.3	55.5	25.3	31.2	27.5	17.5	82.7	183.0	90.9	112.0	54.9	352.0	87.3	63,200
Smoky Hill—Ellsworth.	24.0	47.8	38.0	61.5	40.8	26.4	75.1	70.6	254.0	291.0	63.4	17.7	84.1	61,100
Smoky Hill—Abilene.	239.0	245.0	213.0	233.0	233.0	242.0	419.0	952.0	1,060.0	880.0	378.0	479.0	461.0	334,000
Solomon—Niles.	116.0	142.0	130.0	129.0	128.0	113.0	233.0	608.0	580.0	384.0	224.0	127.0	243.0	176,000
Solomon, North Fork—Kirwin.	34.0	31.7	24.4	31.9	35.5	37.6	14.8	76.8	171.0	92.1	29.2	20.9	52.5	38,000
Solomon, South Fork—Alton.	23.9	49.5	41.2	43.8	44.1	34.3	47.4	41.6	73.0	35.9	10.5	25.3	39.1	28,300
OSAGE RIVER BASIN:														
Osage—Ottawa*.	94.4	68.3	219.0	372.0	159.0	535.0	325.0	1,270.0	1,140.0	85.9	1,450.0	99.0	488.0	354,000

For previous records see "Surface Waters of Kansas, 1895-1919."

*Marais des Cygnes river near Ottawa, Kan.



PLATE I.

March 23, 1922: Rock Creek flooding the store buildings in Burlington, Kan., at 9 p. m.



PLATE II.

The morning of March 24: Results of the flood on Rock Creek at Burlington, Kan.

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MAR 28 1923



PLATE III.

Second flood at Burlington, Kan., on April 8, 1922: Flooded lands above the business district.



PLATE IV.

Republican river at Wakefield, Kan., during the flood of 1915.

VALUE OF STREAM FLOW DATA.

FLOOD PROTECTION.

Severe floods have occurred on all Kansas streams in the past, and although the time interval between these floods is irregular, the floods are periodic, and can therefore be expected to occur again; and it is entirely probable that the floods to be expected will be even more serious than those of recent years. Although the flood of 1903 was the most disastrous which has occurred on the Kansas river, damaging floods occurred in 1904, 1908, and 1915. These four floods caused an estimated damage of \$37,000,000 in the Kansas river valley.

After the flood of 1915 there was a universal cry for protection from other floods, and in 1916 the War Department was authorized to make an investigation of the flood situation in Kansas. Col. C. McD. Townsend, under whose direction the investigation was carried out, reported in part:*

"I have therefore to report . . . that further observations should be made to determine both the volume of flow, and the maximum rate of discharge of various rivers . . . discharge measurements at flood stages are essential . . ."

The Arkansas, Neosho, and Marais des Cygnes river basins have been visited by severe floods many times in recent years, and they are less disastrous than those of the Kansas river because they are of shorter duration, affect a smaller area, or areas less densely populated. Other minor streams are visited by serious floods caused by unusually heavy local rainfall; the flood of Pueblo, Colo., which swept the Arkansas valley in June, 1921, and the flood on Rock creek at Burlington, Kan., in March and April, 1922, are recent examples of what may be expected in any watershed. The Marais des Cygnes, or Osage river, is subjected to a flood more or less serious almost every year, although its floods are generally of short duration.

It is the purpose of the Commission to collect and preserve for future use the essential data on flood flow at as many points in the state as the funds at its disposal will permit. This data is best obtained at a regular gauging station where arrangements have been made for recording the rises in the streams continuously, and where observations of flow are made with sufficient frequency to accurately determine the volume of flood waters. Any comprehensive plan for flood protection on any stream must be based upon an accurate knowledge of the duration and magnitude of the floods on that stream; and any plan of flood protection that will be successful must be based upon a thorough study of all past floods; and the only satisfactory basis for such a study is a record of stream flow over an extended period of years.

This Commission is collecting and preparing data which can be made the basis of study for ample and economical flood-control works, when such improvements are contemplated.

* Floods in Kansas. House Document No. 321, 65th Congress, 1st session.

DRAINAGE.

The problem of drainage is in a way related to floods, in that it involves the removal of excessive water derived from rainfall. The idea in drainage is to construct a ditch of sufficient size and slope or fall to carry this excessive water off the farm lands without injury to the growing crops, or to divert it at the foothills so that it will not spread over the flat bottom lands after heavy rains. In a study of a drainage problem it is necessary to determine what volume of water will have to be carried in the drainage ditch, and to determine how wide and how deep the ditch will have to be, and what slope or fall the ditch will have to have to carry that volume of water. No hasty study or rough estimates will do if the construction of the ditch is economical. Failure to have accurate records of stream flow, where drainage projects are necessary, will either result in a ditch too small to carry the flood waters, or too large to be economical, with a resultant waste of money.

In the proper solution of the drainage problems of the state it is essential that accurate records of flow from the areas to be drained, or from areas of similar meteorological conditions be available for a basic study by the drainage engineers. Accurate information of this character can only be obtained by systematic stream-gauging operations over the entire state, covering a period of time of sufficient length to insure reliable records of flow.

There are at the present time over 150,000 acres of land involved in drainage projects that have cost almost three million dollars.

WATER SUPPLY AND SANITATION.

All large cities depend upon deriving their water supplies from the streams in their immediate vicinities. Although small cities may obtain their water supplies from wells, this source of water is not sufficient for the larger cities, and unless cities are located on large streams they are forced as they grow to extend their pipe lines farther and farther in search of a satisfactory water supply for their inhabitants. It is therefore a vital question as the cities of the state grow, and as the population of the state increases, where the supply of water is to come from. From what source can each city get a supply of water that will provide for twenty-five years of growth at the present rate, and what is the most economical source. How foolish it would be for a city to spend a million dollars on a water supply system, only to find out later that the supply of water was not sufficient, or would not be sufficient to provide for future growth. Satisfactory solutions of city water-supply problems demand an accurate knowledge of volume of water flowing in the various streams in the state, and this information can be obtained only by continued operation of stream-flow measuring stations on all the primary watersheds in Kansas.

The problem of sanitation is intimately connected with the problem of water supply, for the same stream which furnishes the drinking water for a city is in many cases used as a carrier for its sewage; the intake for the waterworks being above and the outlet for the sewers below the city. But how potable is the water of a stream for drinking purposes if this system of sewerage is used farther up the stream at other cities. If the quantity of water in the stream is enough to dilute the sewage sufficiently, no harm will result, but if not, at low stages the stream will be so contaminated that the water-purifying plants can-

not act efficiently, and an epidemic of disease will result. In connection with the sanitary problems in the state it will be increasingly necessary that stream-flow records be available, so that no sanitary system can be constructed which will be a menace to the lives of thousands of people through the use of impure drinking water. Adequate regulations by the State Board of Health can be made and imposed only when that body has access to accurate records of stream flow, which can be made the basis for a sanitary study of the streams.

IRRIGATION.

The western part of Kansas is an area of scant rainfall, where farming is practiced at a considerable risk. That the lands in this section are productive when water is turned onto them through irrigation ditches is clearly demonstrated in the irrigated areas around Garden City. If water for irrigation can be secured and used to supplement the limited rainfall, agriculture in western Kansas will be placed on a more permanent basis. The development of this section of the state is therefore a question of the study of the volume of water which runs to waste during the flood seasons, with the ultimate idea of a system of reservoirs and irrigation works which will store the flood waters in the streams until that water can be used during the productive season. Without records of several years' duration on the flow of water in these western streams, it will be impossible to promote irrigation projects. Stream-flow records are essential in planning and promoting such projects. The United States Reclamation Service has made a systematic investigation of runoff on all the areas in its projects, either constructed or proposed; and the study of stream-flow records has determined the number of acres which could be irrigated, and the amount of capital which could be profitably spent in each undertaking.

The Kansas Water Commission is operating a few gauging stations on western streams, but limited appropriations have made an extensive and intensive study of the streams in the arid sections of Kansas impossible.

INDUSTRIAL USES.

Practically all manufacturing plants use water to some extent in their processes, and where plants are of considerable size the amount of water which they consume becomes enormous. The principal use of water for industrial purposes is in the condenser process of a modern steam plant. In a plant of this type, for each ton of coal consumed there is required 800 tons of water for condenser purposes. Water is therefore a vital question in connection with a steam plant, and the construction of a large steam plant in any locality depends entirely upon the available supply of water for the condensers.

Here again stream-flow records are needed, and industrial companies are making use of what information the Kansas Water Commission has already obtained, and this need and use of stream-flow records will increase with the industrial development of the state. Reliable records of stream flow will result in more rapid development, and eventually the water supply of the Kansas streams will determine the limit of industrial development in the state.

The most extensive private coöperation, and the greatest demand for stream-gauging records have come from industrial and power concerns.

WATERPOWER.

The following is a list of waterpower plants in Kansas, showing the approximate horsepower developed at each plant:

<i>River.</i>	<i>Town.</i>	<i>County.</i>	<i>Capacity hp.</i>
Spring	Lowell	Cherokee	4,000
Big Blue	Manhattan	Pottawatomie	2,400
Kansas	Lawrence	Douglas	1,500
Smoky Hill	Enterprise	Dickinson	1,100
Smoky Hill	Abilene	Dickinson	620
Arkansas	Arkansas City	Cowley	550
Big Blue	Marysville	Marshall	540
Big Blue	Blue Rapids	Marshall	840
Smoky Hill	Junction City	Geary	450
Republican	Clay Center	Clay	450
Cottonwood	Emporia	Lyon	320
Cottonwood	Cottonwood Falls	Chase	270
Solomon	Beloit	Mitchell	220
Neosho	Humboldt	Allen	190
Solomon	Bennington	Ottawa	180
Solomon	Minneapolis	Ottawa	180
Solomon	Delphos	Ottawa	150
Smoky Hill	Lindsborg	McPherson	120
Cottonwood	Cedar Point	Chase	100
Big Blue	Oketo	Marshall	100
Smoky Hill	Bridgeport	Saline	60
Saline	Lincoln	Lincoln	80
Saline	Shady Bend	Lincoln	60
Solomon, N. Fork.....	Lenora	Norton	30

Total waterpower developed in Kansas as of June 30, 1921..... 14,510

The potential waterpower of Kansas has been given by several authorities between 250,000 and 300,000 horsepower. Assuming only 40 per cent of the potential, or 100,000 horsepower that can be commercially developed, this would leave 85 per cent of the practical waterpower in Kansas still undeveloped.

Waterpower depends upon two factors—head or height of the dam, and volume of water available for continuous use. The first factor can be varied to suit local conditions, but the second factor is a function of stream flow which depends upon rainfall. It is therefore absolutely necessary to know the minimum, ordinary, and flood flow of a stream before an economical and financially successful waterpower plant can be designed.

Continuous records of stream flow maintained by the state will hasten the full development of the streams for power uses, and will insure the most intensive development at each site. The development of Kansas streams for waterpower purposes will indirectly help in the flood and water-supply problems of the state, as the most intensive development for power will require the construction of storage reservoirs near the headwaters of the streams, which may be used to store the flood waters, which will be released gradually to make the daily flow of the stream more nearly uniform and considerably larger. Generous use is made of the stream-flow records already collected in studying and improving existing plants by the power companies, and there is an increasing demand for records of stream flow for this purpose.

JUDICIAL AND OTHER USES OF STREAM-FLOW RECORDS.

Stream-flow records collected according to the standard methods of the United States Geological Survey are accepted by all courts and by hydraulic authorities as basic facts, and furnish reliable evidence upon which a sound and equitable adjustment of controversies relating to water rights, inundated lands, flood damage, etc., can be made. Adequate stream-flow records would

have materially aided the argument for Kansas in the adjustment of water rights at the Colorado state line.

Stream-gauging records are also used in determining size of openings for bridges on permanent highways; in a study of the possibilities and development of water transportation; in a study and regulation of channel encroachments by docks and buildings on the river fronts of the larger towns and cities; in a study of the effect of lowering of river channels by dredging and pumping for drainage or commercial purposes; in determining the effects on ground water level and supply by the removal of vast quantities of sand from the river beds; and in many other municipal problems.

Last but not the least use to be mentioned is for accurately forecasting the height to which floods will rise on the lower Kansas streams, by a knowledge



PLATE V.

Flood of Marmaton river in Fort Scott, Kan., 1915.

of the volume of water being fed into these rivers by their tributaries and head streams. Volume of water and the rate it is carried off is the basis for flood forecasts, and the United States Weather Bureau has made generous and welcome use of the data and services of the Kansas Water Commission in its work of safeguarding lives and property in Kansas.

PUBLICATIONS OF THE KANSAS WATER COMMISSION.

Copies of these publications may be obtained until the supply is exhausted, from the Kansas Water Commission, 23 Federal building, Topeka, Kan.

First Biennial Report, 1918.

The Effect of Obstruction to Navigation and Flood Prevention by the Kansas City Northwestern Railway Company's bridge on the Kansas River at Kansas City, Kan., August, 1917.

The Relation of the Kansas Water Commission to the Flood Problems of Kansas, 1918.

Second Biennial Report, 1920.

Surface Waters of Kansas, 1895-1919, 1921 (Compilation of gauge-height and stream-flow records on Kansas streams up to September 30, 1919.)

Coöperative publications of the United States Geological Survey in connection with data collected in its work with the Kansas Water Commission are as follows:

Water Supply Paper No. 456, Surface Waters of Missouri River Basin, 1917.
Water Supply Paper No. 476, Surface Water Supply of Missouri River Basin, 1918.

Water Supply Paper No. 477, Surface Water Supply of Lower Mississippi River Basin, 1918.

Water Supply Paper No. 506, Surface Water Supply of Missouri River Basin, 1919-1920.

Water Supply Paper No. 507, Surface Water Supply of Lower Mississippi River Basin, 1919-1920.

Water Supply Paper No. 526, Surface Water Supply of Missouri River Basin, 1921.

Water Supply Paper No. 527, Surface Water Supply of Lower Mississippi River Basin, 1921.

COMMENTS ON THE WORK OF THE KANSAS WATER COMMISSION.

The following are voluntary expressions regarding the work of the Kansas Water Commission, which have been taken from letters addressed to the Commission:

"The problems so far as Kansas is concerned are largely relative to flood control, and the development of water supplies. The latter problem alone is becoming very serious in many growing communities. . . . The developing and compiling of this data at the original source is a service to these communities which ought to be performed by the state, and the work you are doing will be an increasingly valuable aid in solving these problems."—*H. W. Wagner, Chief Engineer A. T. & S. F. R. R.*

". . . will be of very great value to us in the determination of bridge openings, and in connection with location and development of satisfactory locomotive water supplies."—*E. C. Hadley, Chief Engineer Mo. Pac. R. R.*

"Exceedingly valuable addition to our data on surface waters of Kansas, and will be of particular value to our Division of Water and Sewage of the State Board of Health."—*S. J. Crumbine, M. D., Secretary State Board of Health.*

"Stream-flow data is of much greater value when observations continue over a long period of time instead of only one or two years. We hope that all stations now established will be continued throughout the state, and that other much needed stations can be established with little delay."—*E. C. Curtis, Engineer Kansas Gas & Electric Co.*

". . . cannot say too much for the assistance you have rendered us."—*D. E. Ackers, Hydraulic Engineer United Light & Power System.*

"The legislature should require drainage districts to establish and maintain gauging stations, and to keep correct records as to flood heights and stream flow. It should of course furnish the Water Commission sufficient funds to continue its work."—*Thos. H. Pollock, Attorney Kaw River Drainage District.*

"You have given a great deal of information that is of value to us and we trust you will be able to raise the necessary funds to take care of this good work."—*Arthur Groesbeck, Manager Rocky Ford Milling & Power Co.*

Request for any of the above publications, or for later data which have been collected by the Kansas Water Commission but not published, may be made to E. L. Williams, district engineer, Kansas Water Commission, 23 Federal building, Topeka, Kan.

"The material is certainly invaluable to any engineer in the state whether he be working on problems of sanitation, water supply, drainage, power or irrigation."—*Geo. S. Knapp, State Irrigation Commissioner.*

"We have continual need for information as to stream flow whenever bridges are designed over any of the streams of Kansas."—*M. W. Watson, State Highway Engineer.*

"It is impossible to properly plan sanitary improvements for cities, determine the feasibility and practicability of waterpower development, or properly plan drainage and flood-control improvements without securing information in regard to rainfall, runoff and records of discharge of streams kept over a long period of years."—*Clark E. Jacoby, Clark E. Jacoby Engineering Company.*

"To the engineer engaged in municipal work both from a water-supply and sewage-disposal standpoint this information is of utmost value and will prove of great assistance in solving the problems of these types in many Kansas municipalities."—*Chas. A. Haskins, Black & Veach, Consulting Engineers.*

"It is to be regretted that many of your records first undertaken twenty-five or thirty years ago have not been continuously maintained down to the present time. It is unfortunate the public has been so reluctant to provide the funds necessary to continue the records of stream flow in Kansas. The few long records that exist plainly indicate the importance of the work you have done and the desirability of continuing the records."—*Chas. B. Burdick, Alvord, Burdick & Howson, Consulting Engineers.*

APPROPRIATIONS AND EXPENDITURES OF THE KANSAS WATER COMMISSION, 1919-1922.

FISCAL YEAR ENDING JUNE 30.	Appropriations.			Expenditures.			
	State.	Federal.	Total.	State.		Federal.	Total.
				Water com- mission.	Stream flow.		
1919.....	\$4,000.00	\$2,500.00	\$6,500.00	\$108.00	\$3,219.08	\$2,489.03	\$5,816.11
1920.....	5,000.00	3,550.00	8,550.00	189.45	4,011.77	3,549.79	7,751.01
1921.....	5,000.00	3,400.00	9,000.00	623.98	5,836.95	3,337.01	9,797.94
1922.....	4,000.00	4,100.00	8,100.00	112.50	3,884.23	4,052.39	8,049.12
1923.....	4,000.00	3,500.00	7,500.00				

DISTRIBUTION OF EXPENDITURES FOR STREAM GAUGING.

ALLOTMENT.	Total.	Salaries.	Trans- portation of persons.	Official car.*	Labor.	Equip- ment, field expenses.	Overhead office expenses.
Federal..... 1919	\$2,489.03	\$1,406.50	\$102.52	\$507.51	\$26.85	\$369.37	\$76.28
State..... 1919	3,219.08	1,580.50	32.60	1.75	879.85	692.46	31.92
Total..... 1919	\$5,708.11	\$2,987.00	\$135.12	\$509.26	\$906.70	\$1,061.83	\$108.20
Federal..... 1920	\$3,549.79	\$2,467.50	\$254.06		\$15.50	\$611.48	\$201.25
State..... 1920	4,011.77	2,579.40	62.44	\$634.64	102.20	532.34	100.75
Total..... 1920	\$7,561.56	\$5,046.90	\$316.50	\$634.64	\$117.70	\$1,143.82	\$302.00
Federal..... 1921	\$3,337.01	\$2,085.66	\$308.02	\$521.00	\$3.00	\$181.81	\$237.52
State..... 1921	5,836.95	4,034.76	122.20	709.02	85.10	632.21	253.66
Total..... 1921	\$9,173.96	\$6,120.42	\$430.22	\$1,230.02	\$88.10	\$814.02	\$491.18
Federal..... 1922	\$4,052.39	\$2,675.53	\$269.94	\$287.25	\$13.00	\$629.68	\$176.99
State..... 1922	3,884.23	2,416.87	58.15	588.68	39.25	565.57	215.71
Total..... 1922	\$7,936.62	\$5,092.40	\$328.09	\$875.93	\$52.25	\$1,195.25	\$392.70

*Ford car furnished by the United States Geological Survey.

PROPOSED PLAN OF ACTIVITIES FOR THE NEXT BIENNIUM.

During the next biennium the Kansas Water Commission plans to limit its work almost entirely to the collection of data on stream flow and to the computation of stream-flow records and to the distribution and interpretation of this data to the best advantage.

The Commission with its present appropriation cannot take care of the present stream-gauging operations which have been laid out and carried on with a larger amount of funds than are now available. During the fiscal year 1923 the Commission will be operating more stream-flow stations than ever before with less funds than any previous years since 1919 when less than half as many gauging stations were in operation. Even with the rigid economy which has governed the expenditures of the Commission lack of funds is a serious detriment to the work of the Commission and prevents the extension of stream gauging over territory where it is very evidently needed at the present time, or where records will be extremely valuable in the future.

The Commission plans therefore, on continuing the gauging stations now being operated, with the assistance of private coöperation, with no farther extensions unless additional funds can be secured for the work.

The Commission will also investigate all special problems which may come under its jurisdiction.

BUDGET FOR BIENNIAL PERIOD, 1924-1925.

The following budget for the fiscal years ending June 30, 1924, and June 30, 1925, is proposed for financing the investigations of the Kansas Water Commission:

For hydrometric investigations in coöperation with the United States Geological Survey, and incidental work of the Kansas Water Commission, \$7,000 per year. This provides for the following organization and expenses for collecting stream-flow data according to the standard methods of the United States Geological Survey:

Item.	1924.	1925.
(1) District engineer	\$3,000	\$3,000
(2) Assistant engineer	1,800	1,800
(3) Clerk-stenographer	1,200	1,200
(4) Gauge observers	1,200	1,200
(5) Field expenses	2,400	2,400
(6) Supplies, equipment, etc.	500	500
(7) Incidental expenses of the Kansas Water Commission, ...	500	500
(8) Contingent	400	400
Total operating budget per year.....	\$11,000	\$11,000
U. S. Geological Survey allotment (proposed).....	4,000	4,000
Total budget for state coöperation	\$7,000	\$7,000
Total budget for biennium, \$14,000.		

Respectfully submitted,

KANSAS WATER COMMISSION,
H. A. RICE, *Secretary*.

APPENDIX A.

The following table shows the amounts of state funds expended for stream-gauging work in coöperation with the United States Geological Survey during the fiscal year ending June 30, 1922:

Arizona	\$4,200.00	Nevada	\$3,500.00
California	22,000.00	New York	13,250.00
Hawaii	28,500.00	North Carolina	4,000.00
Idaho	21,000.00	Ohio	6,000.00
Illinois	4,000.00	Oregon	11,500.00
Iowa	3,500.00	Tennessee	3,000.00
Kansas	4,000.00	Texas	14,650.00
Maine	4,350.00	Utah	4,400.00
Massachusetts	3,200.00	Washington	6,350.00
Missouri	10,000.00	Wisconsin	6,000.00
Montana	8,200.00	Wyoming	4,000.00
New Jersey	11,250.00		

In addition to the above amounts, the United States allotted not to exceed \$5,000 to each of these states. In some states permittees of the Federal Power Commission and others have added materially to the available funds.

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